# CHEMICAL & METALLURGICAL ENGINEERING

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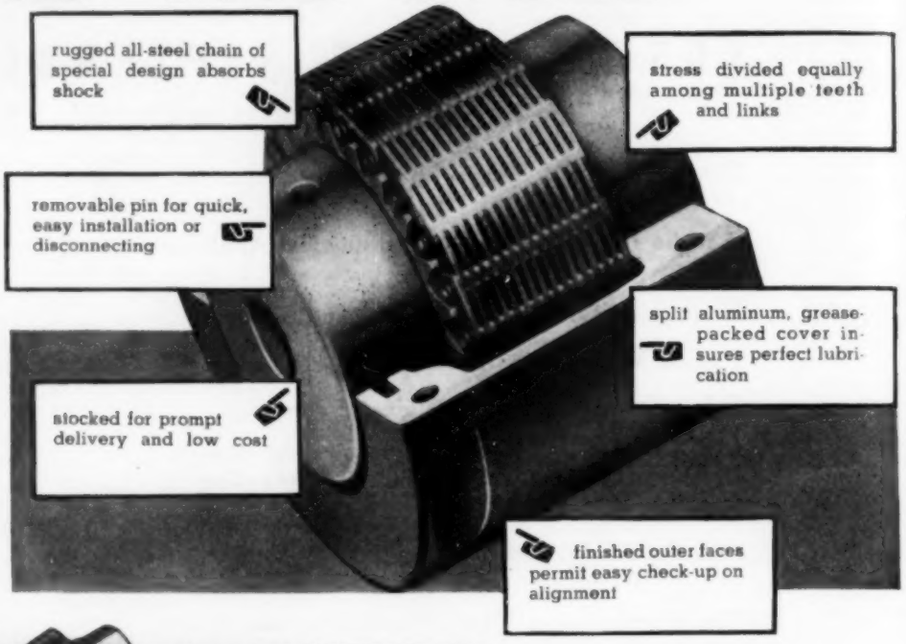
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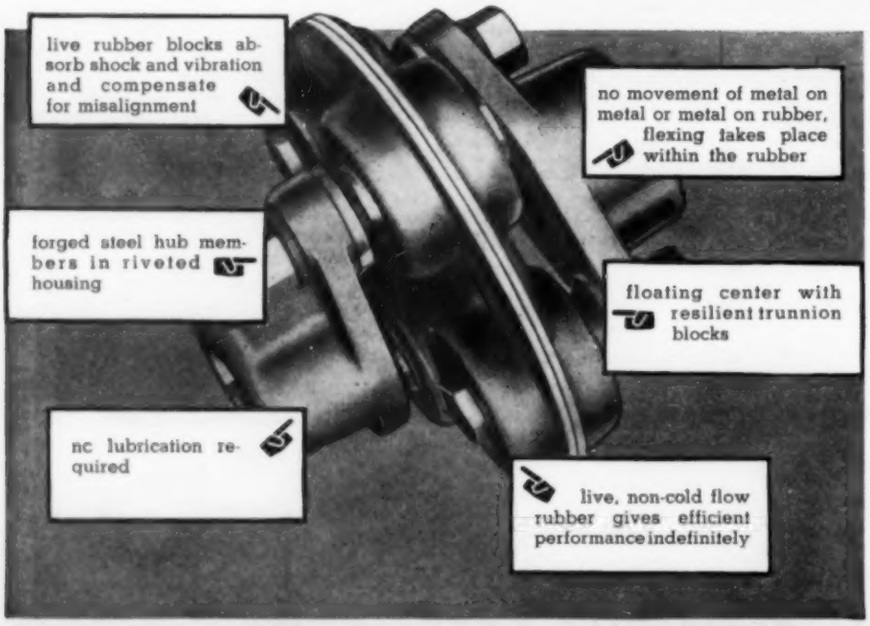
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CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902

VOLUME 44 McGRAW-HILL PUBLISHING CO., INC. NUMBER 9

S. D. KIRKPATRICK, *Editor*

SEPTEMBER, 1937

# On Going Back to School

THOUSANDS on thousands of youngsters—and some not so young—return to college this month, all with varying degrees of enthusiasm. The latter seems to vary in direct proportion with age. Certainly all of us have observed the serious purpose with which the post-graduate or older student from industry returns to the job of completing, or at least improving, his educational equipment. His enthusiasm is an asset to the industry as well as to himself.

Recently an Eastern chemical company sent one of its chemical engineers back to his alma mater for a special summer course in colloid chemistry. The young man became so interested in the probable return on this investment of his company's time and money that he began a little investigation. In a short while he found out that at least 15 other chemical or metallurgical companies have established the definite policy of refunding all or part of the tuition paid by their employees for night school or other extension courses. Some permit instruction to be taken on company time, while others insist that classes be held outside of normal working hours. Our young friend discovered a number of cases where men were sent away for six or eight weeks and, in a few instances, a year or more of graduate work had been provided at company expense. Often the latter involves a contractural relationship whereby the man agrees to remain with his employer for a number of years after receiving his advanced degree.

Our friend's correspondence and contacts led him to believe that much of this sort of thing is going on beneath the surface. Apparently many companies have seen the wisdom of investing in special training for one or two exceptional employees but have hesitated to announce any established policy. They cannot always be blamed for this secrecy, yet it would be stimulating for the chemical industry and profession if all such incentives for graduate study were more widely known. They would help attract better men to the companies involved and perhaps encourage self-improvement among present personnel.

From the broad viewpoint of the chemical engineering profession as a whole, one of the most important benefits would undoubtedly accrue to the universities. Older men returning from industry may have much to learn about recent advances in theoretical knowledge, but in turn they can contribute a practical viewpoint that is too often lacking in the university classroom. Scholarships and fellowships sponsored by industry may also help to bring about better understanding of industrial problems, but much more can undoubtedly be accomplished through the teacher's immediate contact with the experienced employee.

So much is to be gained by closer relation between industry and college that it is a pity more companies do not provide financial encouragement to deserving employees who wish to go back to school for graduate study. Here, it seems to us, is where a careful investment of prosperity dollars can be made to pay dividends in building a loyal, grateful and more efficient personnel.

# *From an* EDITORIAL VIEWPOINT

## BUSY MONTHS AHEAD

SOMEONE has suggested that the fiscal year for the chemical industry and profession might well begin with September. Certainly this new year would be off to an auspicious start. Three thousand chemists, too busy properly to observe Labor Day, congregate for a week in Rochester to listen to 469 assorted papers. October finds the gas men in Cleveland, the electro-chemists in St. Louis, the chemical safety men in Kansas City and the pulp and paper technologists in Savannah. In November comes the big meetings of the petroleum industry in Chicago and the chemical engineers in St. Louis. But December 6-11 brings the real high-spot with the Sixteenth National Exposition of the Chemical Industries. Then about 40,000 representatives of the chemical industries and profession will make their biennial pilgrimage to New York with but one purpose in mind: to learn through personal contact, demonstration and acquaintance, all they can about the latest tools and materials available for solving their production problems. Nothing else seems quite so important in the first four busy months of the new chemical year.

## UNIONS FOR CHEMICAL WORKERS

UNIONIZATION of chemical industry workers will be undertaken aggressively in the near future by C.I.O. according to our Washington observers. This project will be directed by James Nelson, who is president of District 50 of the United Mine Workers, and at present active head of the unit which includes byproduct coke plant and other chemical wage earners.

For quite obvious reasons there will be no claims of inadequate wages or improper hours of employment in chemical plants. Well established official figures, which even the most rabid organizer cannot question, demonstrate the impropriety of such a charge. The issue will be clean cut. It will be solely a question of unionization and recognition of the C.I.O.

Plans of the new chemical workers' organizing committee have not been announced by C.I.O. headquarters at the time this is written. The news will presumably come in the form of direct action at various establishments. The scope of this committee's work is far broader than the industries which make chemicals; it will include several process industries. The executives of each establishment will, of course, have to face many difficult issues. Preparation to meet these will include discussions of the legal rights and duties of employers under the National Labor Relations Act, questions of local law, and the type of policing and protection which may be expected or required if and when picketing is demanded.

This is a difficult time for all industry. But, fortunately, chemical and process executives face these new problems with a cleaner record and a better personnel understanding that has been found in almost any other division of industry which C.I.O. has undertaken to unionize. All will hope that amicable relations between management and workers can be maintained. A spirit of firmness, tempered by generous understanding of the workers' point of view will be hoped for.

## MORE ASPIRANTS FOR ENGINEERING TITLES

MAYOR LAGUARDIA of New York recently announced a special plan for educating street sweepers to become sanitary engineers. (See *Chem. & Met.* p. 299, June, 1937.) Not to be outdone by his illustrious leader, the Hon. Samuel Fassler, Commissioner of Buildings in Manhattan, now urges that the master plumbers should aspire to more dignified engineering titles. Addressing the New York State Association of Master Plumbers, he said, "The master plumber . . . is an industrious, hard-working individual, who fits into the same category as any other specialized engineer. His work is technical. It requires long years of apprenticeship and the successful fulfillment of examination and licensing specifications. Hereafter, instead of using the term 'master plumber,' I am going to substitute the term 'sanitary engineer.' It might be a worthwhile idea for the industry to adopt this phrase officially and to change their association identification accordingly." No action was taken by the 400 delegates present, but they did thank the commissioner for the compliment.

From all this furor of ambition for self-appropriated titles, there comes this thought: Those of us who are sincerely interested in protecting and promoting the proper use of engineering titles may well be concerned with an entirely different approach to this problem. What can we do to help lend the desired dignity to the work of the skilled artisan and craftsman? Many of them are entitled to our respect and if they can be encouraged to raise the standards of their

trades and crafts, they will render a greater service to the public, and at the same time attract to their ranks many more young men who might have been good plumbers, carpenters, or machinists, but who would fail as chemical, civil, or mechanical engineers.

## FACTS AND FIGURES

TWIN-ISSUES of *Chem. & Met.* come to you this month as a result of an innovation in publishing policy that merits a word of explanation and comment. Part I is the regular September issue, complete with the usual number of pages for articles, news and departmental material. But Part II, carrying the title "Facts and Figures of the American Chemical Industry," was designed to serve a very special purpose—in fact, a two-fold purpose.

First was the need within chemical industry itself for assembling and interpreting the essential data on which manufacturing and distribution policies are to be based. To be sure, this is a long-standing and a continuing need which our annual review numbers are designed to fill; but the recent availability of previously unpublished information on employment and the release of important data from the Census of 1935 make the present publication especially timely. Second, but to a large extent the primary purpose of Part II, is our desire to help chemical industry in the vital task of interpreting the facts of its business to those outside of the industry who, in one way or another, will affect its future developments. Bankers, lawyers, doctors, farmers, labor leaders, Congressmen, newspaper editors and radio commentators—all fall into such a category.

To tell the story of chemical industry is a challenge to every one of us—a problem that transcends all others before the chemical industry and profession. Unless there is a better understanding of what we are and what we do, we suffer the loss of public confidence and support. It is very much to our self-interest to see that our story is told in language that can be easily understood—that we give the public the true facts and figures needed to offset the fallacies which the agitators and self-appointed critics have implanted in the minds of the masses. In this educational program, unity of thought and purpose is a first consideration.

So it is hoped that "Facts and Figures of the American Chemical Industry" may be of real service to you. If it is of direct and immediate value in the conduct of your business, by all means keep your copy close at hand for ready reference. On the other hand, if you are willing to take part in the industry's program of public education, why not make it a point to talk over the contents of this issue with someone who would welcome and be benefited by a better understanding of chemical industry? Why not loan your copy to that neighbor who likes to discuss such matters with his doctor, lawyer or merchant friends? And there is always that fellow who thought some of sending his boy to college to study chemical engineering or that science teacher in the high school of whom Young America asks so many questions.

Approximately 40,000 copies and special reprints of "Facts and Figures" have already been published. About half of these go to *Chem. & Met.* readers in the process industries while most of the remainder have been purchased for wider distribution by the Manufacturing Chemists' Association and by leading firms in chemical industry. But there is still a real opportunity for personal service and missionary work. In the words of Allan Brown of Bakelite, "This is a task that cannot be accomplished in a day, in a week, or a month, but we must start now if our business is to protect itself in the court of final judgment—the court of public opinion."

## SILVER SEARCH CONTINUES

A FEW YEARS AGO the leading silver producers of the United States reached the conclusion that the possibilities of silver as an engineering material had not received proper consideration. Accordingly, they united behind a campaign to perform experimental work and to bring the advantages of the metal to the attention of those who might benefit by its use. The second chapter of this program opened in March with a much wider field of interest. Fifteen fellowships covering such phases of the subject as electrochemistry, corrosion, and fungicidal and bactericidal properties have been established at thirteen universities. Already, results of the fundamental research investigations are being reported.

With this strong sponsorship and the guiding hand of Lawrence Addicks the undertaking should bear many valuable results to the process industries and to the chemical engineer troubled by corrosion problems.

By D. S. FREDERICK
ROHM AND HAAS CO.
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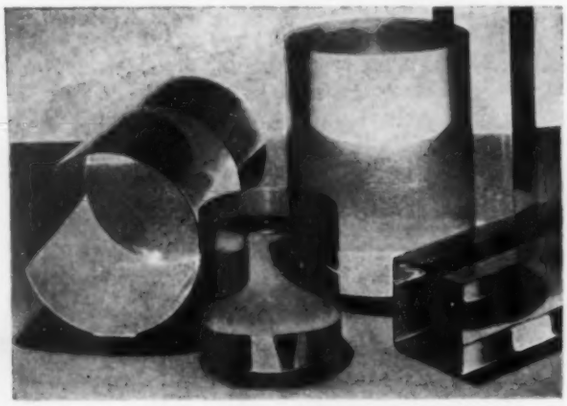
# ACRYLIC RESINS

## Find Industrial Applications

POLYMERIZATION PRODUCTS of acrylic acid and its derivatives are known as acrylic[1] resins. The monomeric compounds which polymerize to yield these resins are all characterized by the 1-3 unsaturated system, $CH_2=\overset{|}{C}-\overset{|}{C}=$. The free methylene group seems essential for the polymerization of these compounds, for alpha-methyl acrylic acid, $CH_2=\overset{|}{C}-COOH$, hereafter
$CH_3$
known as methacrylic acid, polymerizes readily, while its isomer, crotonic acid, $CH_3-CH=CH-COOH$ does not polymerize.

Acrylic acid itself was reported almost a hundred years ago. Redtenbacher,[2] in 1843, prepared a new acid by the oxidation of acrolein with air, and named it acrylic acid. Since that time, experimenters[3], have described various derivatives of acrylic acid, both monomeric and polymeric. However, until 1927, these compounds were available only in small quantities as a method of preparation suitable for their commercial manufacture had not been developed.

**Solid pieces of acrylic resin illustrating colorless transparency of this plastic**



The commercial development and application of the acrylic resins has been due mainly to the perseverance and foresight of Dr. Otto Röhm of Darmstadt, Germany. In 1901, Röhm[4], published the result of his work with Von Pechmann on acrylic acid derivatives. For many years after the publication of his thesis, Röhm worked with the interesting polymerizable acrylic derivatives. His research was interrupted in 1914 by the World War, but not before he had begun to realize the possibilities of the unusual resins he had obtained. By 1927 Bauer[5] working in Röhm's laboratory, had developed a synthesis which made possible the plant production of small quantities of the methyl ester of acrylic acid. Bauer's method of preparation was briefly as follows:

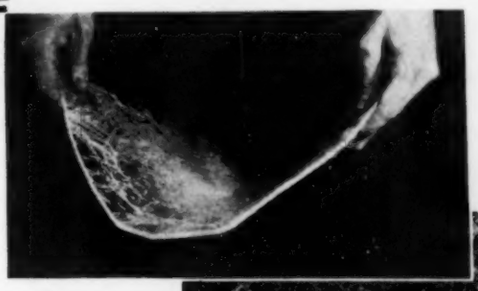
$CH_2OH \cdot CH_2Cl + NaCN \rightarrow CH_2OHCH_2CN + NaCl$

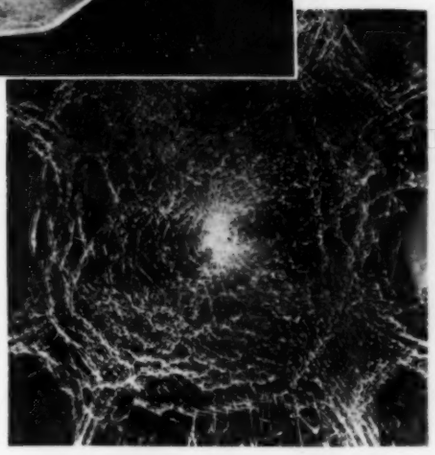
$CH_2OHCH_2CN + ROH + H_2SO_4 \rightarrow CH_2=CH-COOR + NH_4HSO_4$

From that time, the commercial manufacture and use of the acrylic resins has rapidly expanded.[6] In 1931, the Röhm and Haas Co. began to produce the acrylic esters in this country. The synthesis discovered by Bauer was the basis of operations, although this method was modified somewhat to increase its efficiency.

Many derivatives of acrylic and methacrylic acids, such as the salts, amides, nitriles, esters, and acid chlorides yield solid polymerization products. The polymeric esters, however, are at present of most significance from a commercial standpoint. Since many alcohols are now commercially available, polymerized esters of widely differing properties can be prepared.

**The high impact strength, low specific gravity, aging resistance, and ease of forming of acrylic sheets have promoted their use as windows and windshields in airplanes. The acrylic resins are used commercially as an interlayer in laminated safety glass. Notice that although the glass is broken and bent it does not fall apart**





Colorless transparency, stability against aging, thermoplasticity, and chemical resistance to many reagents are general characteristics of the polymeric esters. They range in consistency from soft, sticky, semi-liquids to hard, tough, thermoplastic solids. Since products of these widely varying properties can be obtained by the proper control of the manufacturing conditions, rather than by the customary use of plasticizers, the acrylic resins retain their initial properties indefinitely. Aging and weathering have no effect on the acrylic resins, as they are stable to the effect of heat, light, and oxidizing agents.

After the monomeric esters have been manufactured, they are converted to resins by polymerization. Light, heat, oxygen, and oxygen-yielding compounds such as sodium peroxide, benzoyl peroxide, and hydrogen peroxide act as polymerization catalysts. Antioxidants such as hydro quinone inhibit the polymerization. Since the polymerizations are exothermic reactions, they must be carried out with careful temperature control to prevent their becoming violent. In general, the acrylates polymerize much more rapidly and more violently than the methacrylates.

Acrylic resins may be prepared by polymerization of the monomers in organic solvents, in aqueous dispersions, or in the absence of any diluents. Thus the resins are available in the form of solutions in organic solvents, in aqueous emulsions, or as solid thermoplastics. The concentration of polymerization catalyst, the temperature of polymerization, and, in solution, the constitution and concentration of the solvent, all have definite effects on the characteristics of the polymers obtained. The chemical constitution of the monomers also has an important influence on the characteristics of the polymerization products. The polymeric esters of methacrylic acid are harder and have higher softening points than the corresponding polymeric acrylates. In general, the lower esters in both series are harder, less elastic, and have higher softening points than their higher homologues. Thus, polymethyl acrylate is a tough, pliable, elastic solid, capable of 1,000 per cent extension, while polybutyl acrylate is a much softer resin tacky at room temperature. Correspondingly, polymethyl acrylate is the hardest methacrylic ester, while n-amyl methacrylate polymer is similar to polymethyl acrylate in its physical properties. Isomeric variations in the alcohol group also exert an influence on the physical characteristics of the polymeric esters. Tertiary butyl acrylate polymer, a tough, hard solid, is the hardest of the polybutyl acrylates; polymeric secondary butyl acrylate is similar in properties to polymethyl acrylate; polyisobutyl acrylate is softer than either of the two above-mentioned polybutyl esters, while the n-butyl ester polymer is soft and tacky as described previously.

These controllable modifications of polymerization conditions and chemical constitution afford the manufacturer opportunities to vary the properties of the acrylic resins so that they can be adapted to widely diversified applications. For example, starting with one solvent containing a definite concentration of one monomeric ester, solutions of polymer having a wide range of viscosities can be prepared. From a consideration of these manufacturing controls, it can be easily understood why the acrylic resins are suited for the numerous uses described below.

Acrylic resins were first used commercially in this country as an intermediate layer in laminated safety glass. The extensibility and elasticity of the acrylic resin film made possible the production of a laminated glass which gave a flexible or "yielding" type of break when subjected to a hard impact. As the resin possesses an excellent adhesion to glass, its use as an interlayer eliminates the necessity of an auxiliary cement to bond the plastic to the glass sheets. Glass laminated with acrylic film need not be sealed around the edges, as the resin possesses excellent resistance against moisture. Their colorless transparency, stability, toward ultra-violet light, and strength at low temperatures, also give acrylic lami-

nating films advantages over the cellulose plastics employed in the manufacture of laminated glass. The flexibility of the acrylic resins permits glass laminated with them to be cut more readily than glass laminated with cellulose derivatives.

The acrylic resins used for this purpose are furnished in the form of viscous solutions in organic solvents. A film of acrylic resin solution of carefully controlled thickness is applied to each sheet of glass to be laminated and the solvent removed by forced drying, leaving a film of gum on the glass. This film is moistened by a suitable plasticizer, and the resin-coated glass sheets placed together in such a manner as to force out all air bubbles. The lamination is completed by subjecting the assembly to a relatively low pressure to insure a firm and uniform bond.

This comparatively simple laminating procedure eliminates the necessity of autoclaving at high temperatures and pressures, and facilitates the avoidance of contaminating dirt, which always constitutes a serious problem in working with transparent plastics. The colorless transparency and freedom from haze of acrylic-laminated glass cannot be equalled by glass laminated with any other plastic. The adhesion of the acrylic resin to glass is so good that, although no sealing compound is used around the edges of the laminated sheets, prolonged immersion in boiling water causes no delamination.

The harder acrylic resins are useful in the form of solid thermoplastics. The methacrylic esters of higher softening points, such as methyl methacrylate, are of special interest in this field. As the monomeric esters are mobile liquids which polymerize to solids, the acrylic plastics may be prepared by a casting operation. The polymeric esters are thermoplastic solids which may be used for hydraulic or injection molding. Consequently the acrylic derivatives may be employed as either cast or molded plastics.

Their colorless transparency and resistance to aging and weathering are outstanding characteristics of the acrylic plastics. Due to these excellent properties, the acrylic plastics are finding applications for which synthetic plastics had not previously been considered. They are now available in plane and curved sheets in thicknesses of 0.060 in. to 0.500 in. in sizes up to 36 in. x 48 in. Rods, tubes, and molding materials made of these plastics are under development.

**Properties of an Acrylic Plastic (Plexiglas)**

| | | |
|---|---|---|
| Clarity | Light transmission | 92–95% |
| | Scattering effect | 0.5–1.5% |
| Refractive index | | 1.49 |
| Specific gravity | | 1.18 |
| Hardness | Mohs | 2–3 |
| | Vickers | 17–20 |
| | Brinell | 18–20 (500 Kg–10 mm) |
| Tensile strength (@ 30° C.) | | 7,000–9,000 lb./sq. in. |
| | Elongation at failure (@ 30° C.) | 5% |
| Flexural strength (@ 30° C.) | | 15,000–17,000 lb./sq. in. |
| Impact resistance | | 0.3–0.5 ft. lb. (ASTM Charpy notched bar) |
| Modulus of elasticity (@ 30° C.) | | 6 x $10^5$ lb./sq. in. |
| Coefficient of expansion (@ 30° C.) | | 0.00008/° C. |
| Water absorption by weight (complete immersion @ 30° C.) | 24 hrs. | 0.3% |
| | 48 hrs. | 0.5% |
| | 500 hrs. | 1.2% (equilibrium) |
| Dielectric constant | | 3.0–3.6 |
| Volume resistance | | $10^{15}$ ohms/cm³ |

As the acrylic polymers are thermoplastic, sheets of these materials can be formed or molded into many useful shapes. The high impact strength, low specific gravity, aging resistance, and ease of forming of acrylic sheets have promoted their use as windows and windshields in all types of motor vehicles. The aircraft industry has found the acrylic plastics particularly well adapted to its needs, as formed sheets can be used in windshields and cockpit enclosures to effect stream-lining and thus greatly reduce wind resistance.

The optical properties of acrylic plastics make them suitable for use in spectacle lenses, camera lenses, magnifying glasses, and protective goggles. Acrylic spectacle lenses are now being made to prescription by molding from sheets.

The excellent light transmitting qualities of the acrylic plastics permits their use in edge lighting applications. Edge-lighted signs, advertising displays, and instrumental dials illuminated from hidden light sources can be prepared from these materials.

Acrylic plastic inspection windows are used in various types of machinery where curved sections are necessary or where glass windows might be broken. Practically non-breakable instrument dial covers can be made from acrylic sheets.

In addition, the acrylic resins are, like other plastics, suited for use in fountain pens, boxes, buttons, handles, knobs, lighting fixtures, molded electrical parts, and novelty articles. Since the acrylic plastics offer a combination of their own extraordinary properties with the usual properties of other thermoplastics, it is quite probable that designers and engineers will find many new uses for these products where other plastics could not be employed.

## For Protective Coatings

The properties of the acrylic resins which make them useful in laminated glass and as plastics, also make them suitable materials for protective coatings. The colorless transparent films of these materials have a refractive index of 1.49 and a specific gravity of 1.15. Acrylic resin films, being completely polymerized, so that they contain no unsaturated groups, dry entirely due to solvent evaporation.

These resins are unique in respect to their flexibility and elasticity, as acrylic films extensible in excess of 1,000 per cent can be prepared without the use of plasticizers. The films are not truly elastic, as on stretching they exhibit a certain degree of plasticity. They do not "snap back" to their original form, but require an appreciable length of time for recovery. The molecular weight (viscosity) of the polymers has a great influence on the rate of recovery and tensile strength of the acrylic films. Films of high molecular weight polymers show greater tensile strength and more rapid recovery than do films of lower polymers of the same chemical constitution.

In general, acrylic resin films exhibit excellent adhesion to most surfaces. The softer polymers are always superior in this respect. Baking improves the adhesion to metal surfaces.

The water-white color and permanence of the acrylic coatings are unexcelled. Three year's exposure to weathering and sunlight causes no discoloration, no loss of gloss, or no failure of any kind with the harder films. The water resistance of the softer films is slightly inferior. Acrylic resin films show good heat resistance, withstanding temperatures as high as 350 deg. F. without discoloration. Only after baking at temperatures suffi-

ciently high to cause pyrolysis, does discoloration appear. Acrylic films burn slowly with a non-luminous flame, if they are heated to their ignition temperature.

The chemical constitution of the polymer has a great influence on the resistance of the films against water and chemical reagents. The harder resins are not affected by alkali, sulphuric acid, hydrochloric acid, or acetic acid at room temperature, and show an excellent resistance to both cold and boiling water. The softer films are slightly less stable to these reagents. Although the harder films are not attacked by continued boiling in water, their adhesion is somewhat reduced. Petroleum oils, gasoline, greases, and petroleum hydrocarbons in general do not affect the acrylic resins; they are soluble in aromatic hydrocarbons, ketones, esters, and chlorinated hydrocarbons.

## Compatibility of Acrylic Resins

The compatibility of these resins with other synthetic polymers and natural occurring resins is limited. Rather unexpectedly, many of the acrylic polymers are incompatible with each other. The acrylic resins are compatible with ½ second nitro-cellulose in all proportions, although they show a limited compatibility with cellulose acetate. The ethyl and benzyl cellulose ethers are incompatible. Ester gum, castor oil, dammar, cumar, shellac, and rosin have limited compatibilities. Some compatibility is exhibited with other synthetic resins including the phenol-formaldehyde, vinyl, and maleic acid types. Alkyd resins, clear resinous varnishes, and drying oils are incompatible.

Since the acrylic resins are completely neutral, any type of pigment may be used without fear of reactivity. The permanent water-white color of the polymers enables them to be used in the formulation of pigmented white finishes which will not discolor.

The wide range of viscosities and concentrations in which the acrylic resins are available enables them to be applied by brushing, spraying, or dipping. These coatings are recommended for use where their outstanding properties of water-white color, non-yellowing, petroleum and oil resistance, good electrical properties, adhesion, ozone and chemical resistance, etc., are of importance. Specifically, their application in the field of clear metal lacquers, textiles and artificial leather, electrical insulation, coatings on rubber, glass, lamp shades, porous surfaces containers, and chemically resistant coatings appears promising.

The acrylic ester polymers have proved useful in the field of finishing genuine leather. Due to the uses for which leather is employed the high requirements in this field for permanent flexibility and adhesion have caused many coating materials, successful in other industrial applications, to fail as leather finishes.

In this field, aqueous dispersions of the softer acrylic polymers are used almost exclusively. The coatings, frequently pigmented, are applied to the grain of the leather by hand. The resulting finishes have outstanding flexibility and adhesion, without in any way detracting from the natural "feel" and appearance of the leather. Many coating compositions, excellent from the standpoint of pure utility and protective effect, have proven unsatisfactory as leather finishes due to their inability to preserve the natural characer of the genuine leather.

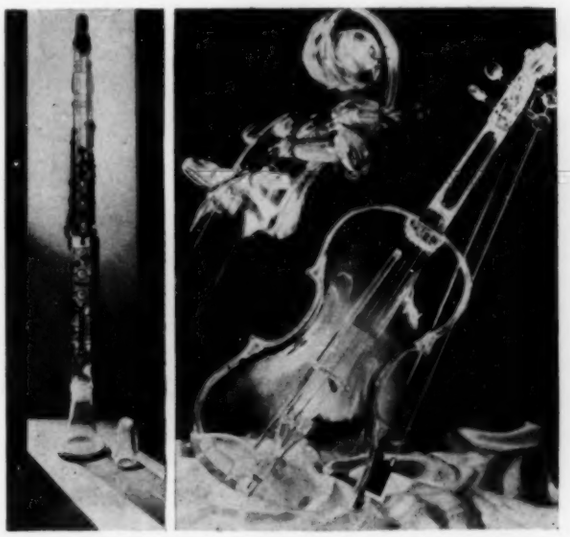
The electrical properties of the acrylic resins suggest their use in the electrical field. As the monomers are mobile liquids which can be forced into small apertures and polymerized in situ to tough, water-resistant solids, they are useful as impregnating agents for electric coils. The shrinkage during polymerization and the volatility of the monomers somewhat restrict their application for this purpose.

Compositions made by compounding the softer acrylic polymers on a rubber mill with fillers such as talc and carbon black have been employed as protective coverings for electrical conductors. These tough, elastic, filled resins can be extruded in the same manner as rubber. Their light weight and flexibility give them advantages over the usual lead coverings in certain applications. Their resistance to oil and ozone also make them desirable substitutes for rubber in electrical equipment.

## Suitable for Thermoplastic Binders

Their permanent properties and good adhesion to all types of materials make the acrylic resins of use as thermoplastic binders. Surfaces to be bonded are coated with an acrylic film and then sealed together under heat and slight pressure. The elasticity and extensibility of the acrylic adhesives permit their use where the bonded materials are subject to flexure and elongation. Wood, metals, textiles, rubber, glass, and many other materials may be cemented together by the use of these thermoplastics.

**These musical instruments made from an acrylic resin, Plexiglas, give some idea of the shapes that can be made from these resins**




(1) Manufactured and marketed by the Röhm and Haas Co., Inc. under the following trade names, registered in the U. S. Pat. Office: Plexiglas and Crystalite, solid thermoplastics; Acryloid, Plexigum, and RHoplex solutions in organic solvents; Acrysol, Primal, and RHoplex W., aqueous emulsions; for the coating of surfaces; Acryloid and Acrysol are sold under license by the Resinous Products and Chemical Co., Inc.

(2) Redtenbacher, *Ann.* **47**, 113-48 (1843)

(3) Caspary and Tollens, *Ann.* **167**, 247-52 (1873)
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Kahlbaum, *Ber.* **13**, 2348-51 (1880); **18**, 2108 (1885)
Weger, *Ann.* **221**, 79-82 (1883)
Mouren, *Bull. Soc. Chim.* (3) **9**, 386-92, 413-15, 417-19, 424-7
Standinger and Kohlschutter, *Ber.* **64**, 2091-8 (1931)
Standinger and Trommsdorf, *Ann.* **502**, 201-23 (1933)
Standinger and Urech, *Helv. Chim. Acta*, **12**, 1107-33 (1929)

(4) Pechmann, von and Röhm. *Ber.* **34**, 427-9 (1901)
Röhm, *Ber.* **34**, 573-4 (1901)
Röhm, "Uber Polymerisations produkteder Akrylsäure," thesis. Tübingen, 1901

(5) Röhm and Haas, A.-G. German Patent 305,530 (Sept. 3, 1919)
Bauer, U. S. Patent 1,388,016 (Aug. 16, 1921)
Röhm and Haas, A.-G. German Patent 571,123 (June 18, 1928)
Bauer, U. S. Patent 1,829,208 (Oct. 27, 1931)

(6) Neher, *Ind. Eng. Chem.* **28**, 267-71 (1936)
Klein and Pearce, *Ind. Eng. Chem.* **28**, 635-9 (1936)
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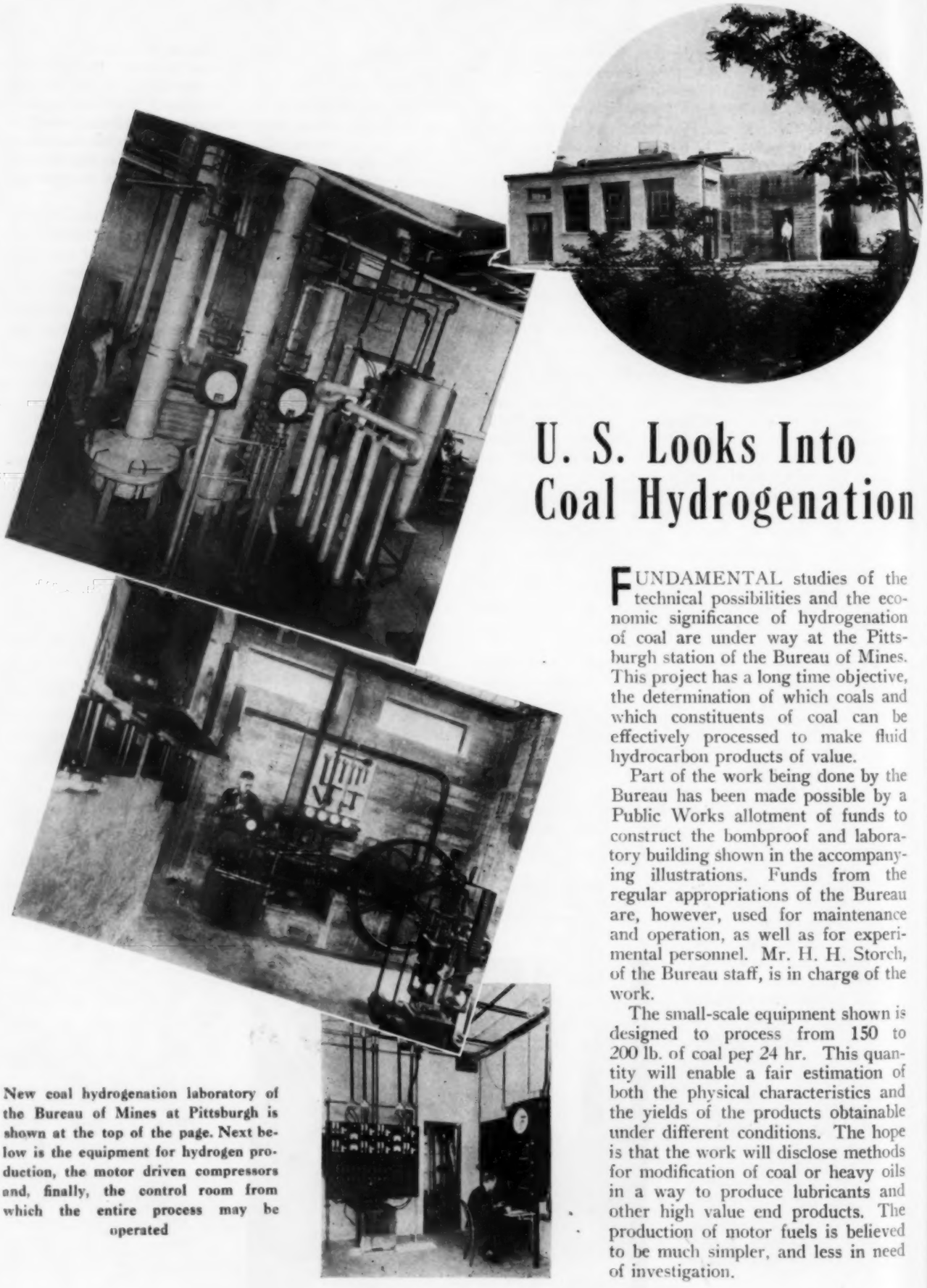


New coal hydrogenation laboratory of the Bureau of Mines at Pittsburgh is shown at the top of the page. Next below is the equipment for hydrogen production, the motor driven compressors and, finally, the control room from which the entire process may be operated

# U. S. Looks Into Coal Hydrogenation

FUNDAMENTAL studies of the technical possibilities and the economic significance of hydrogenation of coal are under way at the Pittsburgh station of the Bureau of Mines. This project has a long time objective, the determination of which coals and which constituents of coal can be effectively processed to make fluid hydrocarbon products of value.

Part of the work being done by the Bureau has been made possible by a Public Works allotment of funds to construct the bombproof and laboratory building shown in the accompanying illustrations. Funds from the regular appropriations of the Bureau are, however, used for maintenance and operation, as well as for experimental personnel. Mr. H. H. Storch, of the Bureau staff, is in charge of the work.

The small-scale equipment shown is designed to process from 150 to 200 lb. of coal per 24 hr. This quantity will enable a fair estimation of both the physical characteristics and the yields of the products obtainable under different conditions. The hope is that the work will disclose methods for modification of coal or heavy oils in a way to produce lubricants and other high value end products. The production of motor fuels is believed to be much simpler, and less in need of investigation.

# FUSION WELDING—
# Its Present Position in Process Equipment Fabrication

EDITORIAL STAFF REVIEW

DURING the past decade fusion welding has advanced from a position where it was often viewed with suspicion, if not active distrust, to a place in the array of fabrication tools so secure that it now enjoys wide application in many sorts of use. Better understanding of its execution, its safeguards and its possibilities has converted most doubters, given it a respectable status and made its many advantages available throughout industry. Particularly in the chemical, petroleum, pulp and paper and other process industries is this true, for in these fields, where high temperatures and pressures and severe corrosion are the rule, welding is peculiarly adaptable. Permanently tight joints, considerable weight saving, applicability to most metals and suitability to better designs are all advantages which it is difficult for competing jointing methods to match. Finally, where welding can be used on a production basis, it can generally be made to show a substantial saving in the cost of fabrication. Its uses in many maintenance problems can be equalled by no other means, either in cost, in speed or in convenience of making repairs.

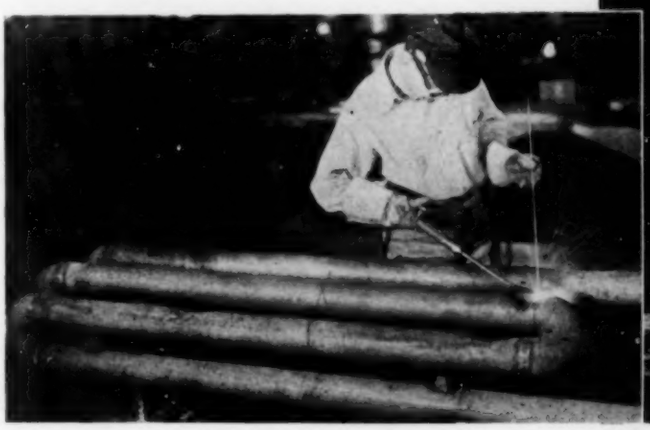
It is difficult, if not impossible, to make a fair appraisal of the relative merits of the two principal fusion methods, arc and oxyacetylene welding. Prior to the perfection of the coated electrode within the past decade, the oxyacetylene process had a definite quality advantage in that the envelope of combustion gases blanketing the molten weld metal tended to prevent the formation of oxides and nitrides and thus made a stronger and more ductile weld than was possible with bare metallic arc electrodes. Proponents of the electric arc process, however, soon found that in steel welding a similar result could be obtained by coating the electrode with a material which, at the temperature of the arc, not only gave off an inert gas to blanket the melting electrode and the puddle of molten weld metal, but also fused as a slag coating on the surface of the metal already deposited and gave further protection to the deposit. On cooling, the slag was readily removed, leaving the metal clean and bright. Apparently in non-ferrous and cast iron welding the oxyacetylene advantage has not been overcome. However, in the bulk of fusion welding, in which mild steel is used, the arc process is now freely employed.

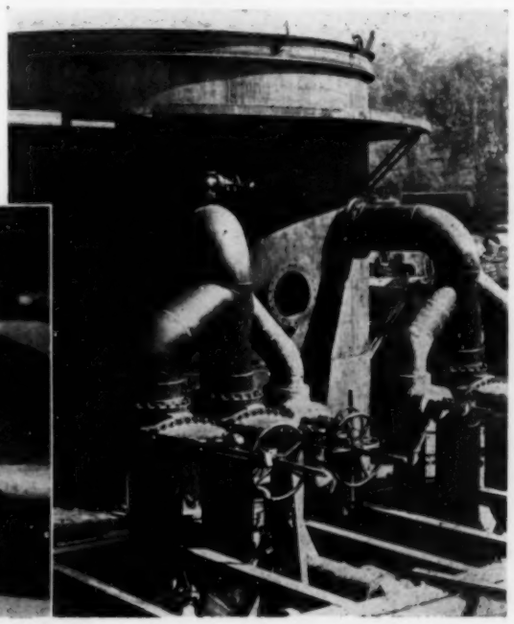
Electrode coating definitely marked the beginning of metallurgical equality between the two processes. As improvements were brought out in rods for oxyacetylene welding, similar improvements were attained in arc electrodes. Today there appears to be no metallurgical advantage for either process. First class welds produced by one method have been found to be the equivalent of

**Below: Gas welding a high-chrome steel coil fabricated with cast chrome steel bends**

**Right: Gas welded connections entering a scrubber; note ease with which insulation has been applied to two of the connections**

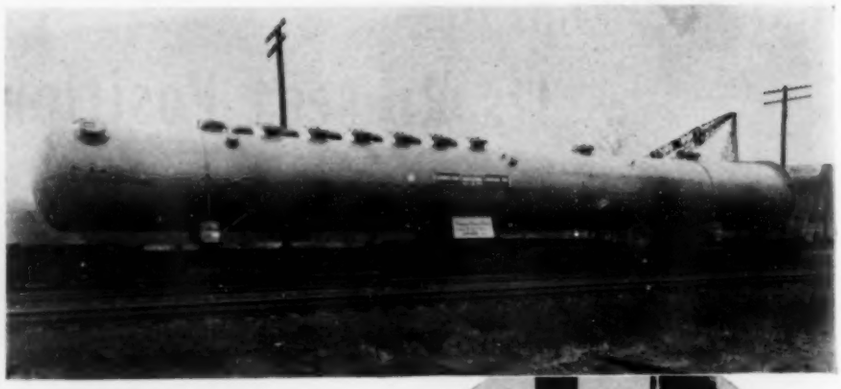
*(Courtesy Linde Air Products Co.)*





the other. This fact is recognized by modern welding codes which give no preference to one fusion process over the other.

So far as the economy of the two processes is concerned, there appears at present to be some room for preference under certain circumstances. In pipe joint welding the two methods compete side by side without evident advantage to one or the other. However, in the fabrication of extremely heavy steel vessels, the more advanced mechanization of the arc process appears largely to have discouraged development of the oxyacetylene method for this purpose. Late in 1935 G. W. Plinke of the Henry Vogt Machine Co. described the construction of a gas welded vessel before the International Acetylene Association, (See *Chem. & Met.*, April, 1936, p. 202.) This vessel, fabricated in accordance with the U-68 requirements of the A.S.M.E. Boiler Construction Code, was the first of its class to be produced by gas welding and, so far as is known, was the only one so produced. Because it was an experimental job and because automatic gas welding equipment was not available, its cost was considerably above what it would have been by arc welding. Nevertheless, its quality was better than the code requirements and the author concluded that with more experience and particularly with semi-automatic or full automatic equipment, gas welding costs in such service could definitely be brought into line.



**Arc welded bubble tower, approximately 100 ft. long and 10 ft. inside diameter, constructed of 1¼ and 1 15/16 in. plate**
*(Courtesy Combustion Engineering Co.)*

**Gas welding a joint in a long 150 lb. steam line running between the U. S. Industrial Alcohol and U. S. Industrial Chemical plants at Curtis Bay, Md.**
*(Courtesy Air Reduction Sales Co.)*

**Arc welding a rigid building frame for Lincoln Electric Co.'s new 200,000 sq. ft. addition at Cleveland**
*(Courtesy The Austin Co.)*

## A.S.M.E. Pressure Vessel Code

Prior to 1931, fusion welding had no generally recognized standing as a means for the fabrication of power boilers and other pressure vessels. In that year, after long deliberation, the American Society of Mechanical Engineers Boiler Code Committee issued its first boiler construction code to make fusion welding permissible. Despite the feeling among certain fabricators that the welding requirements under this code were too severe, the use of the new tool has gone rapidly ahead, now that a sanction so authoritative has been given. Slightly revised in 1935, the Code is now generally accepted by insurance and legislative bodies as well as by fabricators and users, who have found that the unassailable quality of vessels produced according to its requirements is doing much to allay the fears which certain early welding failures aroused.

Three classes of fusion welded unfired pressure vessels are covered by the Code specifications, in addition to the power boiler drums which were the primary interest of the Code committee. The welding requirements of the class for severest service are practically identical with those for power boilers. The class, formerly known as Class I, is now given the designation U-68, corresponding to the section of the code in which it is specified. Unfired pressure vessels fabricated under this section of the code can be used for any purpose, without limitation, whereas definite use limits circumscribe vessels fabricated according to the U-69 and U-70 specifications (formerly, respectively, Class II and Class III). For U-68 welding the joint efficiency is taken as 90 per cent. Test plates produced in a prescribed manner must be welded and tested[1] with each vessel (or with each 200 in. ft. of welded seam, provided that a number of vessels of substantially the same thickness are going through the shop at one time). X-ray or gamma ray radiographs of every

[1] Test plates are welded as an extension of the seam. One is selected by the inspector and cut into coupons which are prepared in a prescribed way for tensile tests along and across the weld, for a bend test and for a test of specific gravity. The tensile strength must be at least equal to the minimum specified for the plate material. The weld metal must show an elongation of at least 20 per cent in 2 in., and by the bend test, an elongation of 30 per cent. Specific gravity must be at least 7.80.

inch of longitudinal and circumferential seam must be made and proof established that the radiographic technique employed is capable of showing a defect with a thickness equal to or greater than 2 per cent of the thickness of the base metal. Certain sorts and numbers of defects are acceptable, but others must be cut out, rewelded and again radiographed. All welds in the vessel must be stress relieved for a time depending on the thickness, at a temperature between 1,100 and 1,200 deg. F., or higher, after which the vessel allowed to cool slowly in a still atmosphere. The concluding test which the vessel must pass is to be put under a hydrostatic pressure of at least 1½ times the allowable working pressure. While at this pressure the joints must be hammered at specified intervals with a sledge of specified weight. Then the pressure is raised to at least twice the maximum allowable working pressure and held there long enough to permit a thorough inspection of all joints and connections.

Considerably less severe requirements must be met in U-69 welded vessels, but such vessels cannot be used to contain lethal gases or liquids, nor liquids at temperatures in excess of 300 deg. F. They cannot be made of plate thicker than 1½ in., nor can they be operated at pressures above 400 lb. per square inch, nor at temperatures above 700 deg. F. The word "lethal" is defined to mean substances which in the gaseous or vapor form are dangerous to life in very small quantities, either mixed or unmixed with air. Hydrocyanic acid and mustard gas, for example, are considered lethal, whereas ammonia, chlorine, natural, manufactured and petroleum gases are not.

To conform with this specification the joint efficiency is taken as 80 per cent. Weld operators doing Class U-69 work must qualify at intervals of six months by the preparation of certain specified test pieces,[2] or at yearly intervals if the operator is regularly engaged in similar work. This contrasts with the requirement for test pieces with *each* vessel in U-68 work. The vessel need not be radiographed, but it must be stress relieved if the ratio of shell diameter to the cube of the wall thickness is less than 100. The final hydrostatic test must be conducted exactly as in the case of U-68 vessels.

The third class of unfired pressure vessel specified by the A.S.M.E. Boiler Construction Code is the U-70 which is acceptable for the storage of non-lethal gases and liquids at temperatures not materially above their boiling points at atmospheric pressure (or above 250 deg. F.), and at pressures not in excess of 200 lb. per square inch. Plates thicker than ⅝ in. may not be used. Qualifications required of the welder are similar to those specified for U-69 welding, although less severe.[3] Such tanks must be given the same hydrostatic test required for the more stringently specified vessels, but stress relief is not required. It should be noted that the definition of "lethal" for U-70 welding is not quite so liberal as for U-69, for it was the intention of the Committee in drawing up the code to exclude such gases as ammonia, chlorine and petroleum hydrocarbons from storage in U-70 tanks.

[2] Test plates of a specified size and of two specified thicknesses are cut into coupons, all of which are tested. For full-section tensile specimens, the tensile strength must be at least equal to the minimum specified for the plate; for reduced-section specimens, at least 95 per cent of that for the plate. The ductility as shown by the bend test must be at least 20 per cent for arc welding, and 15 per cent for oxyacetylene welding. A nick-break test, for which X-ray tests may be substituted, must show complete penetration, absence of slag and oxide inclusions, and a specified maximum of porosity, or less.

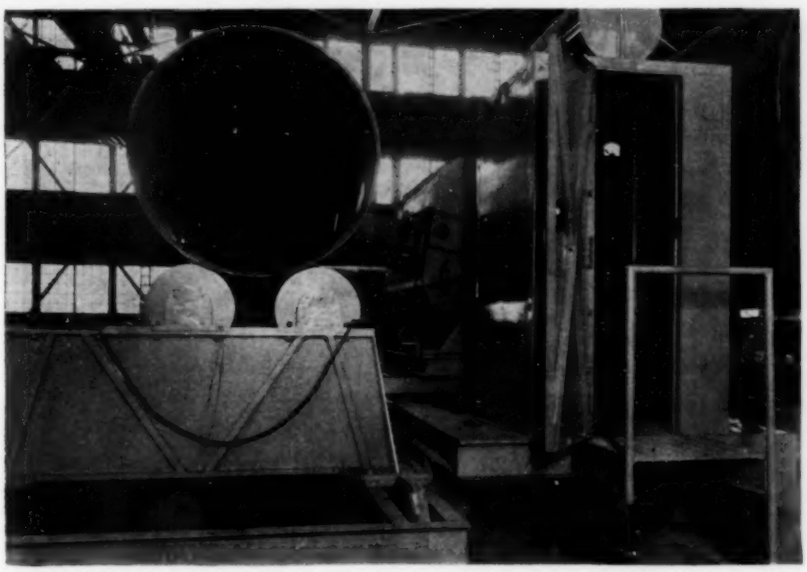
[3] Two test plates of thinner plate than for U-69 are required from which are cut specimens similar to those for U-69, except that the nick-break test is omitted. For the full-section tensile specimens the tensile strength must be at least 90 per cent of the specified minimum for the plate, and for the reduced-section specimens, at least 85 per cent, and not less than 42,000 lb. per square inch. The ductility shown by the bend test must be at least 10 per cent.

## Stress Relief and Radiography

The extensive use of welding which has sprung up in recent years has had a number of beneficial effects aside from the more obvious advantages. For the first time it is now possible to develop the full strength of the plates, while designers have been able to eliminate stress concentrations and particularly points of eccentric loading. Despite good design, however, stresses are set up in the structure due to temperature differentials during welding and the provision in the Code for stress relieving is a necessary one. That it is not an unduly onerous requirement is evident from the fact that the specified method offers a degree of choice to the fabricator. The vessel may be heated as a unit, or a part of it containing the portions to be stress relieved may be heated, or the final girth joints may be heated as a band of specified width. Local heating is also acceptable for nozzles or other welded attachments.

Radiographing of the welds in U-68 vessels is another requirement which has had important consequences in safety. Since welding was first used for joints to withstand considerable stresses, it has been recognized that the parts of the weld which are out of sight are likely to be the critical ones in determining whether the vessel is a potential hazard. Surface defects are fairly readily detected, either visually or by magnetizing

**Radiographing a pressure vessel drum by means of the latest type of 400,000 volt X-ray equipment, capable of satisfactory work on steel up to 4 in in thickness**
*(Courtesy Blaw-Knox Co.)*



the vessel and covering the suspected area with magnetic particles. Even the stethoscope has been of some use in showing imperfect welds. But despite these methods, the finished vessel has necessarily been an unknown quantity, dependent on the skill of the welder and his adherence to proper procedure control methods. Only a means showing the internal condition of all seams has been able to furnish the proof of quality that has been necessary in gaining final acceptance of fusion welding for severe conditions. Although radiographing of joints in vessels for less severe conditions is not required, the practice nevertheless has benefitted all welding. The X-ray has been a valuable research tool in developing suitable welding methods. Likewise, it has often served as an invaluable check on individual welders whose work in some concerns is regularly tested by this means, without regard for Code requirements.

Although the bulk of radiographing under the Code is carried out with X-ray equipment, gamma ray photography also has Code sanction. This method employs the gamma radiation from radium or radium emanation to penetrate the weld and register its internal condition on a photographic film. Up to a thickness of 4 to 4¼ in., the 400,000 volt X-ray equipment now in use by some of the larger fabricators is satisfactorily revealing and rapid. For finished work of greater thickness the Code now requires that the weld be stress relieved when it has reached a thickness of 4¼ in., after which it is radiographed, the weld completed, and the seam again stress relieved. However, there is evidence to support the contention that gammagraphs are satisfactory for much greater thicknesses. As heavier and heavier vessels are produced, therefore, there is the probability that the gamma ray method will gain in acceptance and that it eventually will be sanctioned for the examination of the heaviest welds upon their completion.

## Petroleum Pressure Vessel Code

At the present time there is one other code covering fusion welded pressure vessels which is of interest to chemical engineers. This is the A.P.I.-A.S.M.E. Unfired Pressure Vessel Code, the product of a joint committee of the two societies, which was drawn up to meet the specific needs of the petroleum industry. This industry's requirements were considered somewhat special in view of the extremely high temperatures and pressures, with attendant rapid corrosion rates, introduced by the improved processes and refining methods adopted in recent years. Consequently, the code differed in numerous respects from the A.S.M.E. Code. An important difference is that the A.P.I. Code does not set up various classes of vessel. Rather, allowances for working stresses are graduated according to joint efficiency, the grade of steel plate material used, and the final treatment of the welded joint, such as stress relieving or radiographing, or both.

Pressure vessel fabrication is by no means the only important use to which fusion welding is being put in the process industries. Both plant and pipe line piping is being assembled by its use to a very large extent. Occasional mechanical joints are generally necessary to allow for expansion, repairs or changes, but in many of the newer plants and in most of the recent pipe lines for gas and petroleum products, welding has been used to the greatest possible extent. Not alone process piping but steam piping as well is extensively welded today, particularly medium and low pressure piping, as well as that installed underground or in other concealed locations. A considerable amount of high pressure steam piping has also been satisfactorily assembled by this means. With the various types of weld fittings on the market and with weld-end valves available, it is now possible to weld complete lines, with a minimum amount of labor and time and with a finished job that simplifies the application of insulation, frequently lowers the installed cost, and assures permanent tightness, a condition which is particularly necessary in the handling of numerous hazardous materials.

## Pressure Piping Code

In 1935, following the demand for a pressure piping code which would extend to piping the same assurances of safety that are afforded to pressure vessels, the American Standards Association issued a Tentative Standard Code for Pressure Piping which had been sponsored by the A.S.M.E. Although this code does not as yet carry as much authority as the two pressure vessel codes, it is being accepted to an increasing extent as a means of setting up minimum safety standards for the selection of materials, the design and erection of the component parts of the piping system and the testing of the parts and the completed system. The code is divided into six sections, the first four dealing with power piping, gas and air piping, oil and oil vapor piping, and district heating systems. Section five takes up fabrication methods, and section six, materials for piping systems. One of four chapters in the section on fabrication covers mandatory minimum safety standards for the welding of pipe joints, and deals with definitions, materials, joint design, welding procedure, testing and operator qualification. In some particulars the welding requirements are similar to those of the pressure vessel code, particularly in calling for stress relief in certain circumstances. Pipe having a wall thickness of ¾ in. or greater is to be stress relieved at a temperature between 1,100 and 1,200 deg. F. A period at top temperature of one hour per inch of thickness is required.

Various other codes, sets of rules and specifications concerning welding have been promulgated in recent years. Several of these are of interest to chemical engineers, including the American Welding Society's new rules for the qualification of welding processes and welding operators, and its specifications for filler metal; and the new building codes which are making permissible welded building construction in certain cities, notably New York.

This hasty survey of welding as it applies to the process industries in 1937 has been able only to high spot the points touched upon, while other important phases of the question have been omitted altogether. Types of materials now being satisfactorily welded might have been the subject of an article in itself, as might design for welding, or the use of the torch for repairing and hard facing. The present extensive application of gas cutting as an adjunct to equipment manufacture is another theme to which many pages could have been devoted. What has been the aim in the present paper, however, has been to show that fusion welding has gained an important permanent status in those process industry applications where its advantages made it most useful, while at the same time, its early uncertainties made it most difficult to apply with safety. Welding processes have definitely grown up. High grade welding today need have few limitations in process industries use.

# What to Cover In a Chemical Patent

By H. A. TOULMIN, Jr.*
TOULMIN & TOULMIN
DAYTON, OHIO

A CHEMICAL INVENTION usually involves three factors—product, process, and equipment for performing the process. Depending upon considerations which to the layman may seem complicated and even, at times, conflicting, one or all of these may be patented—provided of course that there actually has been invention.

The average inventor's hope is that he may patent all three. However, nowadays, few inventors are as fortunate as the man who got a patent on the product—deodorized heavy hydrocarbon oils "fitted for use in the arts"—one on "a new process or mode of distilling heavy hydrocarbon oils, by which they are deprived of their offensive odors," and one for "a modification or improvement in the distilling apparatus."

## Pitfalls to Be Avoided

Usually, however, a patent on any one of the three—product, process, or equipment is sufficient to secure to the inventor the benefit of a patent monopoly. But it is important to choose the right one—and there are many pitfalls to be avoided. Here are some points which the chemical engineer can well keep in mind.

The product, in the chemical industry, is usually what the statute calls a "composition of matter." The court has defined it as an "intermixture of two or more ingredients, which develop a different or additional property or properties which the several ingredients individually do not have in common."

That seems simple enough, but consider two cases. In one it was decided that to add an element to an alloy which gave the alloy a new quality which it had not had before was sufficient to avoid infringing a former patent. In other words it was patentable invention. On the other hand the court has said, "A mere difference in the proportions of an alloy, however useful the result may be, does not entitle the originator to the monopoly of a patent." The logic lies in the fact that the product in the first case was a new one—the product in the second a mere change in degree.

The product may be old, but if the method of making it is new and useful, the process for making the old product is patentable.

To be patentable, a process for making a new composition of matter does not need to utilize wholly new methods or equipment. A simple change, such as leaving out one step in the old process may be sufficient. Thus a process for making better oil cakes and producing more oil from flaxseed—both old products—was upheld because the results were valuable. An important part of the invention was the discovery that a useful purpose would be served by omitting one step of the usual process—the grinding and mixing under muller stones—and, instead, doing the mixing in a machine by means of steam.

A chemical process consisting of various steps in treating materials—such as mixing them, grinding them, subjecting them to definite degrees of temperature, pressure and chemical actions, in certain orders—may be new although the machinery for doing these things is old.

However, if a process which is patentable depends upon old and well known machinery the owner of the process patent may encounter rough going in the future. Someone may invent machinery which will perform the process better—with the result that they are both more or less check-mated. This is so important in the chemical industry that I am quoting part of the court's decision:

"One may discover a new and useful improvement in the process of tanning, dyeing, etc., irrespective of any particular form of machinery or mechanical device. And another may invent a labor-saving machine by which this operation or process may be performed, and each may be entitled to his patent. As, for instance, 'A' has discovered that by exposing india rubber to a certain degree of heat, in mixture or connection with certain metallic salts, he can produce a valuable product, or manufacture; he is entitled to a patent for his discovery as a process or improvement in the art, irrespective of any machine or mechanical device. 'B' on the contrary, may invent a new furnace or stove, or steam apparatus, by which this process may be carried on with much saving of labor, and expense of fuel; and he will be entitled to a patent for his machine, as an improvement in the art. Yet 'A' could not have a patent for a machine, or 'B' for a process; but each would have a patent for the means or method of producing a certain result, or effect, and not for the result or effect produced."

## Caution to Equipment Manufacturers

In seeming contradiction to this decision was that having to do with a process for bleaching flour with nitrogen peroxide. The patented process produced the peroxide by means of treating a metallic compound such as iron sulphate with nitric acid. The process which, it was decided, infringed, produced the nitrogen peroxide by subjecting atmospheric air to a flaming arc.

The point which keeps these cases from being in fact as contradictory as they may seem, is that in the first case a better way of providing heat would be an essential part of a process, whereas in the second case what was essential was the nitrogen peroxide, not the flaming arc. The peroxide could be produced one way as well as another and was equally effective one way as another.

Finally, here is a caution to manufacturers of chemical equipment, to keep them from innocently and unwittingly becoming contributory infringers on a chemical process patent. Even though all of the machinery that is used to practice a process is old and well known, if that type of equipment is specially built to perform that process and is furnished with the knowledge that it is to be so used to one who has no right to use the patented process, the supplier of the machinery may find himself a contributory infringer of the process he never practiced, although he could have sold the identical equipment for any other use with impunity.

* Author of Invention and the Law, Trade Agreements and the Anti-Trust Laws, etc.

# Pressure Cooking Contributes Increased Cottonseed Processing Profits

By R. BROOKS TAYLOR
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INCREASED YIELD of superior quality oil, with materially less cooking time, has been demonstrated as a new avenue to increased profits in cottonseed processing by pilot plant experiments recently completed at the University of Tennessee's Engineering Experiment Station. This work, culminating an eight-year program of investigation into the characteristics and processing of cottonseed, has shown that accurate control of the moisture content of the cooked seed, in conjunction with pressure cooking at temperatures considerably higher than those met in usual practice, is capable of increasing the oil production by as much as 10 lb. per ton of seed. At the same time, it has been found possible to produce both oil and cake of greater uniformity and of as good or better quality than by earlier processes, to increase the capacity of the equipment, and to reduce the steam consumption.

Work was initiated in 1929 when the Tri-States Cottonseed Oil Superintendents' Association suggested that the University assist in solving a number of the industry's problems in storage, treating and expressing of oil from cottonseed. Until 1932 work was conducted as a joint project of the Association and the University, and in the latter year the American Society of Mechanical Engineers, becoming interested in the work, organized a special research committee to assist the two agencies already interested in the matter. Some of the earlier results of the work were described by Woolrich and Carpenter in a paper presented before the Process Industries Division of the A.S.M.E. in 1933. (See *Chem. & Met.*, June, 1933, p. 291). With the completion of the earlier phases of the work in 1935, much of it was described in a book published late in that year.

Early in the investigation it was recognized that the cooking process and control of the moisture in the meats during processing offered probably the greatest possibilities for useful laboratory research. Consequently, small laboratory equipment was installed and several small cookers of various types were built and tested. It was found that the use of a closed cooker with internal pressure greater than atmospheric and temperatures considerably above those in common practice, coupled with accurately controlled moisture concentration, resulted in an increased yield of oil. However, it was difficult to evaluate these results under conditions of actual mill operation and the University decided to equip a pilot plant with standard equipment in order to prove the value of the proposed changes under mill conditions.

During the summer and fall of 1936 several oil mills in the Southern area cooperated, either contributing outright or loaning enough equipment to set up a complete press room with the exception of the experimental pressure cooker and its auxiliaries. Owing to its interest in soil conservation and the economical production of nitrogenous feeds and fertilizers in the Southern area, the Tennessee Valley Authority agreed to assist in the design and construction of the special experimental cooker and to furnish a part of the labor necessary for its installation and operation.

It was decided not to install delinting and separating equipment but to procure hulled and separated seed from an operating oil mill. Although it had been suggested that the meats might deteriorate in transit to the experimental plant, precautions were taken to prevent this and no difficulties were encountered.

With the proffer of assistance both from the several oil mills and from the T.V.A., the University proceeded with the construction of a new brick and concrete building to house the pilot plant. This was completed on December 15, 1936 and the equipment was all installed and in operation on Feb. 2, 1937. The plant was operated more or less continuously from then until March 13.

## Aims of the Investigation

Primarily, the work conducted during the 1936-37 season had as its objective the investigation on a full scale oil mill basis of a proposed method of cooking cottonseed in a closed container under pressure greater than atmospheric and at temperatures substantially higher than those ordinarily employed. The intention also was to develop methods and equipment for accurately controlling the moisture content of the seed during processing. Furthermore, it was hoped to develop processing methods giving products of more uniform quality, to reduce cooking time and increase the capacity of the equipment, to increase the yield of oil and to improve the quality of cake and oil.

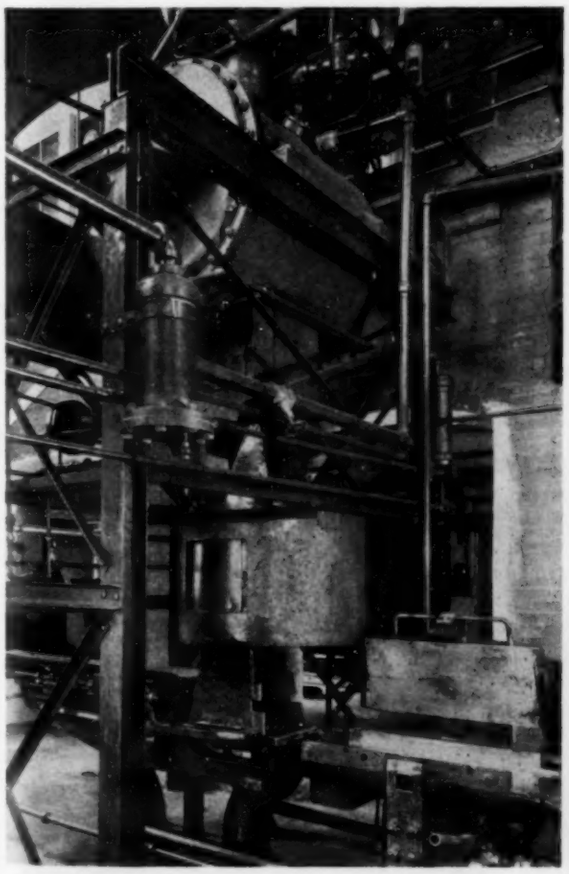
Over 275 test runs were made under widely varying conditions of time, temperature, pressure and moisture concentration. Chemical analyses, made according to the official rules of the Oil Chemists Association, were run on the raw meats, cooked meats, press cake and crude oil. These chemical control data, constituting a most important phase of the experiments, were made possible by the completely equipped laboratory supplied by the University for this purpose. Between 2,000 and 3,000 chemical determinations were made.

During the test runs it was shown that the cooking process is definitely a time-temperature function and that

relatively modest increases in temperature permit substantial reductions in cooking time. At cooking temperatures of 270 deg. F. or higher, the time is apparently reduced to that required to raise the temperature of the meats to the cooking temperature selected, plus that required for the subsequent removal of excess moisture. With the pressure cooker used in these experiments, thorough cooking was accomplished at 270 deg. F. or higher in a total time of 15 min. or less, as compared with normal oil mill practice of 60 to 90 min. at 230-235 deg. F. Owing to the heat insulating characteristics of cottonseed, in order to obtain such rapid rates of heat transfer, the cooker was designed for a maximum amount of heating surface, high jacket temperatures (340 deg. F. or more) and thorough agitation of the meats during the entire cooking process.

In regard to oil yield, results were most encouraging. With cooking temperatures of 270 deg. F. or higher, and proper moisture content control, it was found possible to maintain an average "standard" (ratio of oil to ammonia in the cake) of 55 as compared with "standards" of 65 to 70 for average oil mill practice. On the basis of "prime" seed (3.5 per cent ammonia and 18.5 per cent oil), 10 to 15 points reduction in the "standard" is equivalent to from 6⅔ to 10 lb. increase in oil yield per ton of seed, a gain of 67 cents to $1 per ton of oil at 10 cents per pound. The quality of cake and oil was uniformly equal to or better than that produced in the best mill practice.

**Experimental pressure cooker discharging to hydraulic former**



With the exception of the pressure cooker and moisture control apparatus, all equipment was of a type customary in oil mill practice.

The five-high Buckeye 42 in. x 14 in. crushing rolls were of much greater capacity than required and so were modified to use only the three top rolls and a width of about 28 in. So modified, they had a capacity of about 1,000 lb. of meats per hour and gave excellent results, rolling to a thickness of 0.006-0.008 in.

## Design of the Cooker

The experimental cooker was a completely steam jacketed horizontal cylinder, fitted with steam tight charging and discharging doors at the top center and bottom center, respectively. An agitator with a narrow helical blade was provided to give thorough agitation during the cooking period and to carry the meats out through the discharge door at the end of the cooking cycle. The inside diameter of the cooker was 33 in. and its length, 40 in. Originally designed to hold one press charge of slightly over 300 lb. of meats, it was found in actual operation to have sufficient capacity to handle two press charges or about 625 lb. per batch when operated to capacity. The cooker was equipped with reducing valves to permit the delivery of steam to the jacket at a range of temperature from 180 to 400 deg. F. In addition, a jacketed steam generator was provided for supplying a measured quantity of steam to the batch for the purpose of adding moisture to the meats. Instead of steam, cold water could be admitted to the generator jacket, thus making its action reversible. Should it be desired to reduce the moisture content in a batch, the moisture could be driven over, condensed in the coils and measured in an auxiliary measuring tank. A vacuum pump was provided for holding a vacuum on the cooking chamber when cooking was to be done at very low temperatures, while for the removal of condensate from the jacket when cooking with sub-atmospheric steam pressures, a small condensate pump was supplied. The necessary gages and thermometers were provided to keep an accurate record of cooking conditions.

The hydraulic system included a French four-plunger combination low and high pressure pump and two 6-ton Buckeye accumulators, one for a high pressure of 4,200 lb. and the other for a low pressure of 500 lb. per square inch. A French hydraulic former was provided for compacting the cooked meats prior to charging to the standard Callahan 14 in., 15-box hydraulic press. The latter had press plates in first class mechanical condition and turned out cakes weighing slightly under 15 lb. each. A steel barrel suspended from a scale beam was provided to catch and accurately weigh all oil discharged from the press.

The physical layout of the equipment is in part evident from the accompanying illustrations. Seed delivered at one end of the building was dropped into a floor hopper and elevated by a conveyor to the rolls. From the rolls it discharged through a screw conveyor to the boot of an elevator arranged to discharge the crushed meats into a steel storage hopper suspended beside the elevator. The purpose of this arrangement was to permit intermediate storage of the meats between chargings of the cooker. When it was desired to start the cooker, meats were dropped from the bottom of the hopper into the elevator boot, elevated and diverted to a weigh hopper suspended on a spring scale and mounted on a small crane so that it could be swung from the elevator spout to the cooker.

One further piece of apparatus which proved extremely useful should be mentioned. For some time the University had been working on an instrument for the rapid determination of moisture content of the seed. The instrument used was an adaptation of one already in wide use for the determination of moisture in tobacco and similar products. It operates on the principle that the resistance of a mass of moisture-containing material to the flow of an electric current will vary with the amount of moisture present. A quantity of the meats placed in a small insulated cylinder is subjected to a pressure of 200 lb. per square inch. Copper plates in the bottom of the cylinder, separated by a gap of about ⅛ in., carry a difference in potential of 110 volts. The flow of current between the plates, as measured with a milliameter, is an indication of the

moisture content. Although not suitable for determining moisture below 6 per cent, this instrument gives reasonably accurate results in practice, with the percentage of error usually less than 5 per cent, compared with the standard laboratory process. Through its use, moisture determinations require only a few minutes as compared with several hours by the usual laboratory process.

## Operation

Hulled and separated cottonseed meats, to the extent of 1½ to 2 tons per day, were secured by truck from the night run of the Rome Oil Mill at Rome, Ga., reaching Knoxville at about 6 a.m. The rolls were started immediately and about half the day's supply crushed in 2 to 3 hours. The remainder was rolled at about the middle of the shift. As soon as a sample was available, a moisture determination was run on the rolled meats with check determinations made at regular intervals during the day. On the basis of the moisture determinations, each batch was weighed accurately into the cooker, batches being calculated to make one press charge of 15 cakes. A normal day's run was 10 to 12 batches. Floor sweepings and cake trimmings were not dumped into succeeding batches, but were accumulated in tubs to be run the following morning, thus avoiding contamination of the experimental batches and also serving as a means of heating up the press each morning.

After charging, the cooker was closed and the desired moisture content added in the form of steam by means of the steam generator. Records were kept of cooking time, cooking temperature, internal cooker pressure, jacket pressure and the moisture correction. Test temperatures ranged from 180 to 285 deg. F. with the cooking time adjusted by trial to give thorough cooking of the meats without scorching. This time varied from 1 hour for the low temperature batches to 7 min. for a few of the high temperature batches.

Meats cooked at below 200 deg. F. for 1 hour were not thoroughly cooked. Owing to the excessive time required, the lower range of cooking temperatures was not explored thoroughly. It is entirely possible, however, that further research with low temperature cooking may be of value in connection with the possible utilization of cottonseed cake for such industrial uses as the manufacture of glue and plastics. Possibly low temperature cooking will be of particular interest in connection with the processing of soybeans for industrial uses.

Thorough cooking was accomplished at all temperatures above 200 deg. F. However, the use of the vacuum pump and condenser was necessary in removing excessive moisture from the batches cooked at temperatures below 220 deg. F. As cooking temperature was increased above 200 deg. F., cooking time was shortened correspondingly. Optimum cooking times for various temperatures were approximately: 30 min. at 240 deg. F., 25 min. at 250 deg. F., 20 min. at 260 deg. F., and 12 to 15 min. at 270 deg. F. Although batches cooked quite satisfactorily at 270-285 deg. F. in 7-8 min., this practice did not allow sufficient time for the removal of excess moisture. Since a high moisture content in the cake results in lower oil yields, the probable optimum cooking time for this temperature range is around 10 min.

Physical characteristics of the meats cooked at these temperatures are apparently conducive to more effective oil extraction. When held at the correct moisture content, the meats appear to lose all their pasty characteristics with the formation of a more porous press cake from which the oil flows freely. Thorough and complete coagulation of the proteins at these temperatures is thought to be the explanation of this result. One beneficial effect of high cooking temperatures is the ease with which the press cloths are stripped from the cake.

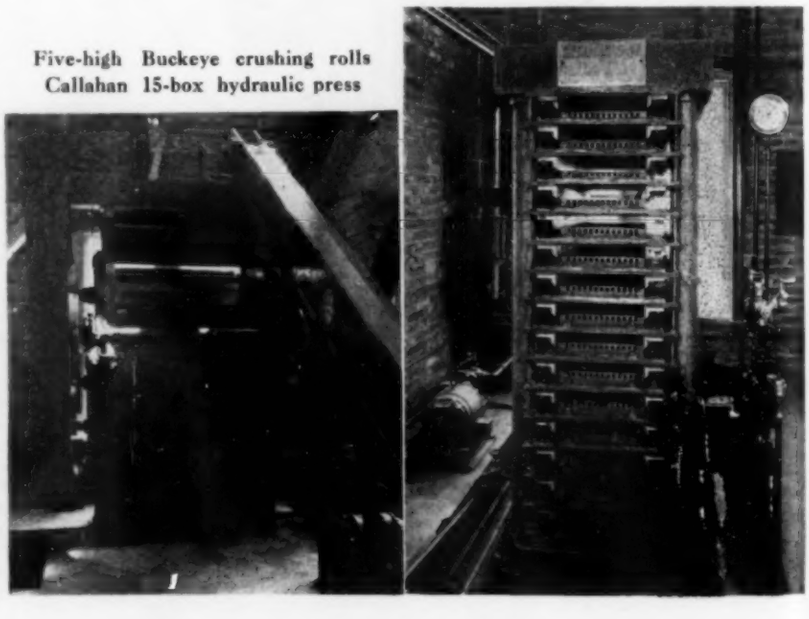
Cooking at the higher temperatures has been shown to have no harmful effect on the oil. Of six batches cooked on the same day from the same load of meats, three were cooked at 235 deg. F. for 45 min. and three at 270 deg. F. for 15 min. Oil from the lower temperature batches had an average refining loss of 4.6 and an average color of 4.7, while that from the higher temperature batches had an average refining loss of 4.2 and an average color of 5.0. Furthermore, oil extraction clearly improved with increasing cooking temperatures. The "standard" dropped almost uniformly from an average of 66 for batches cooked at 230-235 deg. F., to an average of 54 for batches cooked at 265-275 deg. F. These figures are taken from analyses of the center of the cake and represent the averages for approximately 180 test runs. All other results given in this report are based on analyses of the entire cake.

In order to determine steam consumption, the condensate from the cooker jacket was measured for one full day of operation, a total of 12 batches. Calculated to the basis of whole seed, the steam consumption was 250 lb. per ton of seed. Using a factor of evaporation of 8 lb. of steam per pound of coal, this is equivalent to 31 lb. of coal per ton of seed, or, at $3.50 per ton for steam coal, a cost of 5.4 cents. Since the cooker stood idle for half the time between pressings and batches were only half of the maximum cooker capacity, the losses per ton of seed were doubtless at least twice that for capacity operation. When operated to capacity, it is believed that this cooker will show a fuel cost less than 5 cents per ton of seed, assuming the factor of evaporation and the price of coal mentioned above.

Among other results determined, it was found that the best oil yields were obtained with cooked meats having a moisture content ranging from 4½ to 5½ per cent. Corresponding cake moisture content was 7-8 per cent. The effect of variation in final moisture on the residual oil in the cake is illustrated by two groups of batches cooked under identical conditions but with a variation in cake moisture of 1 per cent. The average "standard" for seven batches cooked at 270 deg. F., with an average cake moisture content of 7.9 per cent, was 53. The average "standard" for nine batches cooked at 270 deg. F., with an average cake moisture content of 8.9 per cent, was 57.

Although 7-8 per cent is the optimum moisture content for best oil yields when sampling the entire cake, considerably better extraction was recorded from much drier batches when the center of the cake alone was sampled. Several batches

**Five-high Buckeye crushing rolls**
**Callahan 15-box hydraulic press**



were recorded with "standards" of 40 or slightly over when sampling by this method.

When the ammonia content of the meats was high, it was possible to cook much drier and still maintain the required plasticity. The higher percentage of oil in the meats is thought to be the reason. Optimum moisture content in the cake was from 5½ to 6½ per cent when the ammonia content of the cake was from 9 to 10 per cent.

During most of the experimental work, no effort was made to control the internal pressure in the cooking chamber. This pressure varied from zero at 230 deg. F. to a maximum of 25 lb. gage at 270 deg. F., depending on the temperature, amount of moisture present, and the unoccupied space in the cooker. For batches of equal size, the internal pressure varied with the cooking temperature and the total amount of moisture contained in the batch provided, however, that the amount of moisture was no greater than that required to maintain the vapor pressure equivalent to the cooking temperature. No additional quantity of moisture would raise the pressure above this point unless the temperature was also increased. For any given temperature the internal pressure was constant when the moisture concentration was controlled within close limits. A suggestion, which was tried on several batches with excellent results, was to control the final moisture content of the cooked meats by manually regulating the internal pressure on the cooker, with complete disregard for the initial moisture content of the meats. Equipment is now being developed for the automatic control of final moisture by means of this principle. Further research is, of course, necessary in order to perfect this equipment.

When these experiments were started, it was felt that certain other variables might have an effect on the results. It was determined, however, that no beneficial effect resulted from removal of the air from the cooker by exhausting with the vacuum pump immediately after charging. However, this practice is probably worthy of further research. It had also been suggested that sudden releasing of the internal pressure on the cooker might rupture or explode the oil cells with a consequent increased yield of oil. No such increase was recorded for batches subjected to a sudden pressure release, even on the occasion when the 12 in. discharging door accidentally blew open, instantly releasing about 15 lb. of pressure on the cooker.

Experimenting with the effect of rolling on best cooking conditions and optimum oil yield, it was found that meats rolled to a thickness of 0.006 to 0.008 in. were desirable. The thickness of rolled meats was checked daily with a micrometer caliper and the thickness controlled as nearly as possible to 0.075 in.

Considerable experimenting was required to produce a cake of uniform thickness and density. With dry meats the cakes tended to have soft ends. This was overcome to some extent by pulling up on the press cloth during forming so as to make a cake somewhat thicker at the ends and slightly shorter. Cakes were also often thinner at the front than at the rear, a condition which was corrected by slight modifications in the forming equipment.

## Pressing Procedure

Pressing procedure was conducted so as to conform with good mill practice and little work was done except to determine the most suitable rate of application of the pressure. After the first few days, a uniform pressing time of 30 min. was adopted. The low pressure choke was regulated so as to require from 5 to 6 min. before the high pressure was applied and the high pressure choke was regulated to require a like time to reach the maximum pressure of 4,200 lb. per square inch. Although it was difficult to evaluate the results of variables in this procedure, owing to the many other variables that were being changed from batch to batch, it was evident that best results were obtained with a slow and uniform application of both high and low pressures.

Several batches were pressed for 60 min. The oil was weighed at the end of 30 min. and again at the end of 60 min. Apparently about 3 lb. of additional oil was produced during the extra 30 min. of pressing, although the entire gain was not verified by the difference in "standard" between batches pressed for 30 min. and for 60 min. Hence the results so far as pressing time was concerned were not conclusive.

Except to make sure that pressure cooking and higher temperatures did not have an adverse effect upon the refining loss, little work was done to improve practice in this connection. Toward the close of the experimental work, a few test runs were made to determine the effect on the refining loss of admitting live steam into the batch of meats as soon as the cooker was charged. A total of 17 batches so cooked had from 4 to 15 lb. of steam measured in as soon as the charging door was sealed. These were compared with seven batches cooked under like conditions except that the moisture was accurately controlled within the limits for maximum oil yield. A group of eight batches to which 10 lb. of steam or more was added showed an average "standard" of 60, while a group of 9 batches to which 4-10 lb. of steam was added had an average "standard" of 57, compared with 53 for the seven control batches. The steamed batches showed a higher cake moisture content but a somewhat lower refining loss. The results of these tests were not obtained until after the plant had been shut down and there was no opportunity for further work on this problem. It is believed, however, that substantially the same "standard" and refining loss would have been obtained for the steamed batches as for the control batches if the former had been cooked down to optimum moisture content for maximum oil yield. Further research is needed to verify this conclusion.

## Ammonia Content of Pressed Cake

Ammonia content of the pressed cake was usually around 8 per cent. Generally speaking, so far as oil extraction is concerned, there is practically no choice between processing meats which yield a cake of 8 per cent ammonia content and those which yield a cake of 9 to 10 per cent ammonia content. From the standpoint of press room capacity, however, it is obviously advantageous to a mill to operate on a high ammonia content since the volume of meats per ton of seed to be cooked and pressed is much less when the ammonia content is high. The press room capacity is increased approximately 13 per cent for an increase in ammonia content of the cake from 8 to 9 per cent. This is based on calculation, comparing the relative weights of 8 per cent cake and 9 per cent cake obtained from a ton of prime seed.

Deterioration of the raw meats, as measured by the increase in free fatty acid content, seldom was more than 0.1 per cent from the time the meats were received in the morning until the end of the day. In order to check this matter further, however, 200 lb. of rolled meats was placed in a metal can and held for two months at a relatively high temperature. A periodic check of the free fatty acid content showed a steady increase ranging from 0.9 per cent on receipt to 1.1 per cent after 2 days, 1.35 per cent after 5 days, 3.55 per cent after 8 days, 5.0 per cent after 12 days, and 8.8 per cent after 19 days.

In summary, the Experiment Station feels that the principal objectives of this research have been accomplished. Cooking at pressures above atmospheric, with temperatures in excess of 265 deg. F. and with moisture content accurately controlled, cooking time has been reduced, oil yield has been increased and the quality and uniformity of the finished products have been improved. Novel features of both processes and equipment are being protected by patent applications wherever possible. This is not for the purpose of restricting application of this work but, on the contrary, to insure that the processes and equipment will be used for the best interests of the industry as a whole.

Coal tar distillation plant, the Vitkovice Iron Works near Oderberg, Czechoslovakia

# A Lesson May Be Learned From Czechoslovakia

By KARL FALK

HAUS OBERSCHESIEN
GLEIWITZ, GERMANY

HISTORICAL and geographical influences have largely determined the structure of the chemical industry of Czechoslovakia. It was in the present province of Bohemia, adjacent to Germany, that in the 16th century the first chemical plants in Europe were established to manufacture the so-called Bohemian sulphuric acid. This was made from pyrite deposits and is to be differentiated from English fuming sulphuric acid. These original plants are still in existence as chemical enterprises, but large scale chemical production began only around the middle of the last century, with the development of the processing industries. The first soda factories using the Leblanc process were erected around 1850, at which time the Aussig Verein, the leading chemical company of central Europe, was also established. Then, as well as now, the production of the chemical industry was based largely on the available raw materials: wood, coal, and lignite, iron and manganese ores, graphite, mercury, antimony, arsenic, gold, silver, lead and zinc and uranium and radium, etc.

Whereas the chemical industry before the War supplied a domestic market of 50 million people in addition to doing a considerable export business, after the War a complete re-orientation was necessary. Production had to be reduced to the actual requirements of the new Czechoslovak Republic with less than 15 million inhabitants. Before the War, for example, the Aussig Verein supplied the total copper sulphate requirements of present Austria, Hungary, northern Italy, and Yugoslavia. Today there are more than eight new copper sulphate plants in these same areas, and Czechoslovakia's annual production of copper sulphate has declined from over 1,000 carloads to less than 100, which is being produced in only four factories—enough to supply domestic requirements. Partly for the same reason only 30 to 40 per cent of the capacity for producing sulphuric acid is now needed. The only way in which these losses could be equalized was to reorganize the chemical industry to manufacture finished products for the domestic market and new specialized products for export.

As an inland country not enjoying the advantages of cheap sea transport, Czechoslovakia is unable to compete in world markets in heavy chemicals, fertilizers, etc. On the other hand, production costs are low, and thus cheap export of specialized products is possible. Since domestic purchasing power is relatively low, the chemical industry must look for foreign markets to dispose of surplus production after supplying chemicals for the domestic processing industries and agricultural fertilizer requirements. In general it may be said that she attempts to make her production complimentary to that of German and American chemical industries, which, incidentally, also have considerable interests in the Czechoslovak concerns. On the other hand, the larger Czechoslovak concerns are helping financially and technically in building up the chemical industries in the new Balkan States. A "Centre Economique" was established by the Little Entente at Prague last year to stimulate the exchange of Yugoslav ores and Roumanian oil in return for Czechoslovak industrial products. The shoe and rubber firm Bata plans to establish a factory to produce carbon black from Roumanian methane gas, and the plans also provide for the establishment of several other chemical factories in Roumania and Yugoslavia and the extension of planting of cotton and soy beans in these countries.

The leading organization in the chemical field, the Association of Czechoslovakian Chemical Industries includes 400 concerns in 22 divisions. Although there is still considerable foreign capital in the chemical industries, there is a tendency to introduce more local capital wherever possible, and lately there has been a strong trend to consolidate smaller companies to avoid uneconomic competition. According to the latest industrial census, of the 140 price, market, and production cartels and agreements in the Czechoslovak chemical industries, 50 are international. In chemicals as well as in general foreign trade, Czechoslovakia's leading partner is Germany, with whom she conducted 19 per cent of her foreign trade of $600,000,000 in 1936. (United States was second with 7.6 per cent).

The leading chemical concern in Czechoslovakia is the Aussig Verein for Chemical and Metallurgical Products, in which I. G. Farben and du Pont are also interested. Its production program includes a well-balanced variety of products, sulphuric, hydrochloric, nitric, and hydrofluoric acids; caustic soda, caustic potash, sodium sulphate, potassium permanganate; mineral colors and coal-tar dyes; organic intermediates, as developers and bases, formic acid, oxalic acid, solvents, trichlorethylene, etc.; saccharine, nitrates, and phosphate fertilizers, active carbons, ferro-alloys, etc. Its original units are located at Aussig in the northwestern tip of Bohemia. Last May it opened a new aniline factory, at the beginning of 1937 a new sulphuric acid plant at Sillein, and it plans to build several additional chemical factories. The Verein is also close to the Vitkovice iron works at Moravia-Silesia. An affiliate of the Verein, the Oderberg Chemical Co. at Bohumin has recently undertaken the production of photographic chemicals.

Besides producing heavy and organic chemicals and fertilizers, the Fertilizer and Chemical Co. at Kolin manufactures cyanides for the extraction of gold and silver and has a subsidiary making radium and its preparations. The largest radium mine in the world is located at St. Joachimsthal, a valley in the Czechoslovak Erzgebirge, and it was from Joachimsthal uran-pitchblende that the Curies made their great radium discoveries. Joachimsthal's bid for fame is also based on the fact that a few hundred years ago from the silver mine in Joachimsthal the first "Thaler" was coined, and from this is derived the modern word dollar.

## Ammonia and Nitric Acid Plants

To provide a basis for munitions industries as well as artificial fertilizers, several synthetic ammonia and nitric acid plants have been erected, among them the nitrate plants in Marienberg, Semtin, and Moravska Ostrava. Considerable progress has been made in the manufacture of safety explosives for mining, and Czechoslovak munitions, along with Skoda arms, are being exported in increasing quantities to Roumania, Poland, Lithuania, Austria, and France. In Czechoslovakia's preparedness program, the chemical industry is highly mobilized.

The international Dynamite Nobel concern has recently been reorganized in Czechoslovakia as well as in other European countries. Explosia has extensive plants at Bratislava, the capital of Slovakia, and at Semtin near Pardubice in Bohemia for the manufacture of explosives, dynamite, TNT, nitrocellulose lacquers, etc. The company is also interested in heavy chemicals, acids, sulphur chloride, and carbon bisulphide, and it is stated that the Bratislava plant is now concentrating on the manufacture of Bakelites and other synthetic resins.

Synthesia, also located at Semtin, is a newer company producing acids for explosives, as well as synthetic nitrogen, oleum, soda, phosphates and fertilizers.

The Moravian hard coal basin in the north is another chemical center. The largest synthetic nitrogen and ammonia plant is situated at Moravska Ostrava. Other large fertilizer plants are located nearby, as well as seven large coking plants, partly built around the Vitkovice steel industry, which produce large quantities of gas and pool their coal-tar for distillation. Rütgers Co. is an important independent industry for the treatment of coal tar. One of the three plants for making salicylic acids and compounds is also located at Moravska Ostrava, and here the first plant for producing synthetic gasoline is being established. It uses the Fischer-Tropsch process and plans to produce 25,000 to 30,000 tons of gasoline, propane, butane, and paraffine annually. Nearby at Bohumin, insecticides, mercury compounds, and saccharine are being produced.

With extensive forests, especially in the eastern Carpathian and Slovakian districts, dry wood distillation is carried out on a large scale. Methyl alcohol, formaldehyde, acetic acid, charcoal, and especially cellulose from beech wood is exported extensively. The country has 19 cellulose and 64 paper mills with a yearly capacity of 250,000 tons.

## Alcohol From Potatoes

Considerable alcohol is obtained from small farm distilleries using potatoes and grains. The beet sugar processing industries are highly developed, and as one of the world's leading producers Czechoslovakia has installed beet sugar refining equipment in England, Russia, Austria, and other countries. Special quality barley, hops, and malt account for a large brewing industry producing Pilsen, Budweiser and other beers.

A company Biochemia was formed at the end of 1936 at Brno to produce lubricants, disinfectants, sprays, glues, veterinary preparations, protein fodders, fish meal, etc., for members of the widespread agricultural cooperatives. A group of dairy cooperatives in Moravia is planning to produce "lanital" wool from milk, using a process similar to the Italian Snia Viscosa staple fiber process. One of these dairies at Treptschein has been producing 5,000 kilograms of dry casein daily since September of last year.

Another new establishment is Organochemia at Prague, which is taking over several pharmaceutical companies and is buying interests in others. It is engaged in producing fine chemicals, especially medicinal products based on salicylic raw materials. Salt, a government monopoly like matches, is gained as rock salt in Ruthenia and in evaporation salt works at Slovakia.

The list of chemical firms and products is by no means complete, but it indicates the variety of chemical production in Czechoslovakia. A foreign observer is impressed especially by the newer plants using the best foreign and locally-developed processes, and on the whole the chemical industry is becoming well balanced and seems justified in looking forward to a healthy future development.

# THE INERT GASES
## —Their Production and Uses

By H. S. COLTON
CONSULTING CHEMICAL ENGINEER
CLEVELAND, OHIO

**Oxygen, nitrogen and crude gases for the production of argon, neon, and other gases being made in the modern plant of the Superior Air Products Co., Newark, N. J.**

FEW OF US realize the wealth contained in the atmosphere of our own homes. The average small house contains over 200 cu.ft. of argon, which at current prices is worth slightly less than an equal number of dollars, and while the neon contained in the same house is less than a quarter of a cubic foot, its market value is nearly $50 when pure.

In 1894 when Sir William Ramsay first discovered an inert gas in the air, he named it "argon" after the Greek "argos" meaning "wanderer" or "idle one." The other argonauts of the chemical table were discovered in the years 1895 to 1900 and were named "helium" from "helios" (the sun), "krypton" from "kryptos" (hidden), "neon" from "neos" (new) and "xenon" from "xenos" (strange). All of these elements are gases and no one has succeeded in combining them chemically with other elements. Argon in recent years has belied its name in that it is now performing useful work and two others of these inert gases are every-day articles of commerce. Xenon and krypton, however, are so rare that they are not used to any extent commercially, although they would be superior to argon for incandescent lamp use if it were possible to produce them in sufficient quantities at a reasonable cost.

### Gases Put to Work

The uses for these gases, while very different in practice, all depend on the gas as a filler of space. Incandescent lamps filled with argon have replaced the old nitrogen-filled and vacuum bulbs of former years. It is more inert than nitrogen and represses the ionization of the hot tungsten filament, thus preventing a black coating from depositing on the glass, as in the case of the evacuated lamp. Both xenon and krypton would be even better for this purpose due to their higher atomic weights, but their production—at a cost allowing them to be used for this purpose—is still an unfinished task of the chemical engineer. Neon is, of course, the gas used to fill the glass tubing in neon signs. Helium, while one of the rarest of these gases, has found use due to its occurrence in concentrated form in certain wells in the southwestern part of the United States. Since it is light and non-inflammable it makes an ideal lifting medium for dirigibles and balloons. Helium has also been used to dilute oxygen for breathing purposes where men must work under pressure. It is much less soluble in the blood than nitrogen, and, consequently, when the pressure is released, it does not "boil off" and cause the painful and serious ailment known as the "bends." Helium has also been suggested and used as a diluent for oxygen in breathing for weak patients, the lighter helium being less of a strain on the lungs than nitrogen.

The procurement of these gases in a sufficiently pure state to make them of commercial value is not such a simple matter, and, indeed, if it were not for the chemical engineer, the cost of obtaining them would be so high that it would prohibit their commercial use. The inert gases have been known for forty years, and a raw material supply for their production has been readily available in unlimited quantities. Chemical means for producing the pure gases have also been known since their discovery, but

**Some of the characteristics of the inert gases**

| Gas | Atomic Weight | Name Derivation | Boiling Point | Recent Price | Use | Specific Gravity Air = 1 | Parts Air to One Part Gas, in Air |
|---|---|---|---|---|---|---|---|
| Helium | 4.00 | "Helios" (The Sun) | −268.9° C. | $0.025 per cu. ft. | (1) Breathing (2) Filling balloons. | 0.138 | 245,300 |
| Neon | 20.2 | "Neos" (New) | −245.9° C. | $226.50 per cu. ft. | Electric signs | 0.696 | 80,800 |
| Argon | 39.91 | "Argos" (Inactive) | −185.7° C. | $0.90 per cu. ft. | Incandescent lamps | 1.380 | 106 |
| Krypton | 82.9 | "Kryptos" (Hidden) | −151.8° C. | $198,000 per cu. ft. | None (too expensive) | 2.868 | 20,000,000 |
| Xenon | 130.2 | "Xenos" (Strange) | −140.0° C. | $425,000 per cu. ft. | None (too expensive) | 4.525 | 170,000,000 |

only in recent years has the engineer worked out the cost and equipment problems of production. While efficient air compressors and fractionating columns allow argon to be manufactured as a primary product, the best method of production is as a by-product in the manufacture of oxygen, nitrogen and liquid air, where the larger volume of these common gases will absorb most of the overhead and compressing charges. Neon, xenon and krypton are not manufactured directly as primary products, and the same would hold true for helium if it were produced from the atmosphere.

## How They Are Manufactured

The method of producing rare gases may be divided into two steps: (1) the production of a concentrated crude gas, and (2) the refining of this crude.

In the case of helium, we of the United States are fortunate in that nature has undertaken to do the concentrating step for us. Otherwise this would be very costly due to the very low percentage of helium in the atmosphere. The crude concentrated helium is obtained from some unusual gas wells occurring in the Southwestern States, and the crude concentrates for the other gases, argon, neon, krypton, and xenon, are obtained from liquid air columns.

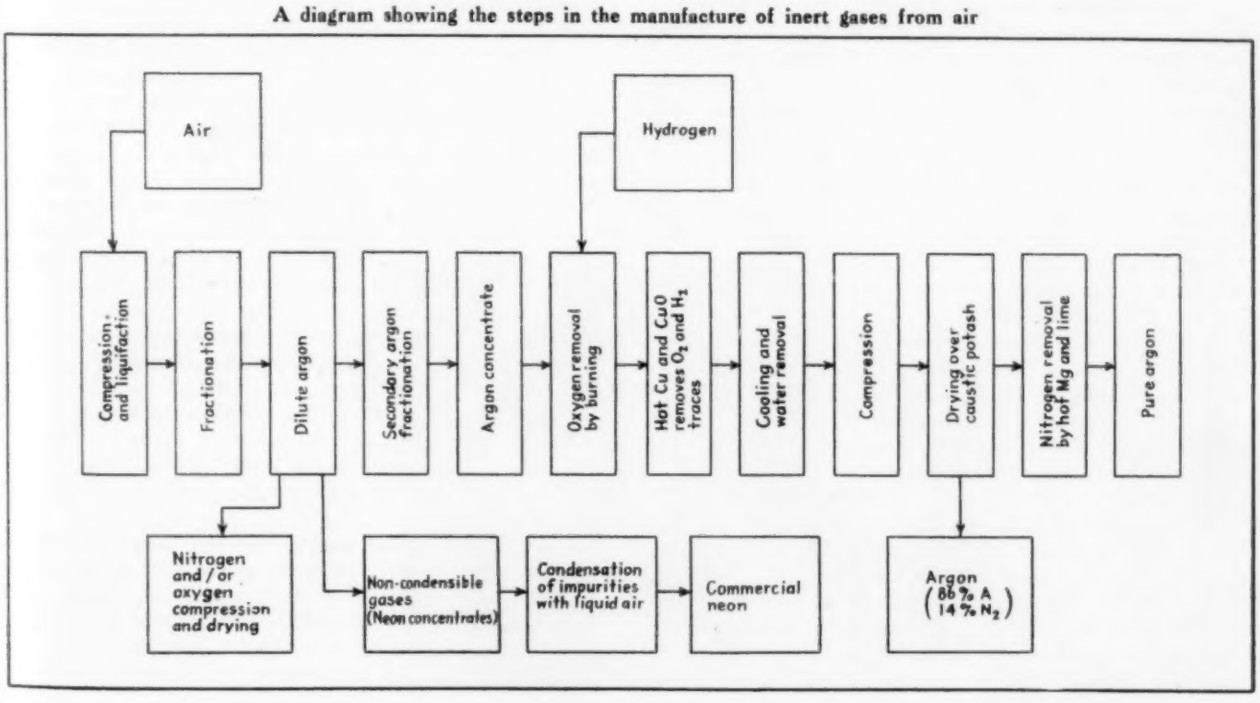
In the case of argon, which is the most important of these rare gases, the first gas bled off the column will run less than 10 per cent argon and it is concentrated to, roughly, 60 per cent argon in the small secondary column. In the case of one or two manufacturers who run their column for argon only, discarding the oxygen and nitrogen, the concentrate may run as high as 85 per cent argon. The balance of the gas in both cases is oxygen and nitrogen, the removal of which constitutes the second step in the production of pure argon.

The elimination of oxygen is relatively simple, being accomplished by burning out with hydrogen. Complete combustion is not always obtained, however, and it is difficult to exactly balance chemically the hydrogen with the oxygen. For this reason, the burned gases, which now contain argon, water vapor, and small amounts of oxygen and nitrogen are passed over red hot copper and copper oxide. The copper reacts with any oxygen present removing it as copper oxide and the copper oxide present reacts with any hydrogen to form water vapor and metallic copper. After passing over the copper, the gas is cooled and the water vapor condensed. The gas is then compressed, dried over caustic and put up in cylinders. This gas now contains approximately 86 per cent argon and 14 per cent nitrogen and is the standard gas used to fill incandescent lamp bulbs.

For special types of lamps a higher grade of argon is required; so the nitrogen must be removed. This is accomplished by passing the gas over metallic calcium and magnesium under pressure. These metals react with the nitrogen to form nitrides, while the argon, being inert, passes on and is obtained as a nearly 100 per cent pure product. The mixture of 86 per cent argon and 14 per cent nitrogen can also be purified by liquefaction and fractional distillation, a process which removes nearly all the nitrogen, after which the argon is passed through a flaming calcium arc to remove the last trace of nitrogen.

The equipment for removing the nitrogen employs special alloy steels in its manufacture. The reaction of magnesium and/or calcium with nitrogen does not proceed at ordinary temperatures and pressures, but when the temperature is raised to redness, the nitrogen begins to react with the metal, slowly and incompletely, to form the nitride. In order to speed up this reaction and carry it on toward completion the pressure must also be increased. Since ordinary steel loses strength very rapidly above red heat it is necessary to use stainless steel or even special alloy steels containing elements such as molybdenum, which serve to toughen the steel at elevated temperatures. As the magnesium and lime charge used to remove the nitrogen is continually being consumed, and since it cannot

**A diagram showing the steps in the manufacture of inert gases from air**



be rejuvenated as was the case of the copper used to remove oxygen, it is often necessary to repack these pressure tubes. Joints that can be easily broken for recharging and yet be perfectly tight at high temperatures and pressures even after repeated use, must, therefore, be provided. Careful design and selection of materials of construction is absolutely necessary here, and it is probable that forty years ago when Ramsay discovered the rare gases, it would have been impossible to manufacture satisfactory equipment to remove nitrogen from argon on a commercial scale.

One of the interesting features in the manufacture of argon is the method for analyzing it. Ordinary gas analysis methods fail here since there is no chemical which will react with these inert gases. To determine the analysis of a mixture of argon, nitrogen, and oxygen, the density balance is used in conjunction with an Orsat apparatus. The oxygen is first determined by absorption according to standard practice. The specific gravity of the gas is then determined with a density balance and from this the nitrogen and argon can be determined after making allowance for the oxygen present. For a quick analysis the thermal conductivity cell, which measures the thermal conductivity of the gas mixture, may be used. This is similar in principle to carbon dioxide recorders now on the market.

The methods of purifying the other inert gases are similar to the methods of purifying argon. Neon and helium are termed "non-condensible" gases due to their low boiling points and are usually purified with liquid air which condenses any other gases present.

There are some industries that could profitably produce one or more of these rare gases that have probably never even considered it. As has been mentioned, the first and most expensive step in manufacturing a rare gas is concentrating the rare gas to a percentage where it can be purified. The atmospheric nitrogen industry is today throwing away large volumes of tail gases which contain relatively high proportions of the rare gases. All of the liquid air and oxygen and nitrogen manufacturers could readily produce one or more of these rare gases as a by-product yet only one or two are doing this. If the cost of the rare gases can be reduced, their production and field of usefulness will undoubtedly be increased as there are numerous possible uses for them which are now barred on account of high cost. The inert gases are now doing useful work and it may be that some day these rare gases will be common articles of commerce.

# Resin-Bonded Plywood For Construction

WOOD has been familiar and universally used as a material of construction for so long that it is often thought of in terms of its weaknesses. On the other hand, it has a combination of properties that have always merited consideration for many uses in the plant. Thus, in the majority of species, it is characterized by relative chemical inertness, light weight, great strength in the direction of the grain, workability, ease of construction, easy painting, and good insulating properties. The wide variety of available species also permits the selection of some particular property desired.

A basic disadvantage of wood—low strength across the grain—is overcome by the manufacture of plywood, where each successive layer of sawn lumber or wood veneer runs at right angles to both adjacent layers. This plywood construction not only distributes the strength of the panel, but also markedly reduces its swelling characteristics, so that a given panel will retain its size and shape much better under fluctuating atmospheric conditions. The plywood construction, however, introduces a new material next to each successive layer of wood, namely, an adhesive, and if this is not as chemically resistant as the wood itself, a new weakness is introduced in attempting to overcome the older ones.

In the past few years, a synthetic resin, binder in the form of Tego resin film has been adopted by a number of plywood manufacturers. By applying it with wholly new operating equipment and technique, they have succeeded in establishing Tego-bonded plywood as a well recognized and distributed commercial product. This plywood is made with the dry resin film interleaved between layers of wood, which sets in a hot press to give a permanently cured joint between the layers of wood.

The chemical resistance of this new type of plywood is really limited only by the properties of the wood employed, or by the protective coatings used on it. Bearing in mind that wood varies markedly by species, it may be stated in general, that unprotected wood has withstood deterioration in hot and cold water for periods of many years. Acids on the whole do not affect it at the lower concentrations, and usually the lignin in the wood is the first point of attack. Alkalis, however, not only attack the lignin, but also produce swelling, and by infusion easily penetrate to further attack.

More specifically, fiber destruction of wood by acid begins at a pH of 2 and below, and it will be borne in mind that wood extracts themselves have a pH of from 3.3 to 6.5. Wood has found successful use in the presence of hydrofluoric acid vapors, and in tanks and filter frames for such acids as acetic, citric, phthalic, oxalic, and 6 per cent sulphuric. Oxidizing acids, however, are more destructive. Alkalis do not attack wood noticeably at a pH of 7 to 11, so that wood can be used in industries employing mild alkalis, for example, textile mills. The alkali, incidentally, gives protection against fungus attack. Wood is not recommended for contact with strong alkaline salts, such as soda ash. Most common solvents, except carbon bisulphide, have no effect on wood.

The Tego resin bond in plywood has resistance of the same nature as wood, although to a considerably higher degree. However, its principal features in plywood are its complete insolubility in cold or boiling water for an indefinite period of time, and its repellance of any mold growth in damp locations, which ordinarily hastens delamination and destruction of plywood. The resin itself is in an irreversible, cured condition, and among the commoner chemicals, is attacked only by strong alkali. Its interposition between the layers of wood, therefore also serves as a protective sheathing against the inner layers.

Summarizing, wood panels are now being regularly produced which offer the many advantages of wood in construction, without several of its former drawbacks. Tego-bonded plywood is made in a wide variety of woods, in different panel thicknesses, and in regular sizes up to 8 x 12 ft. It can also be permanently curved.

# Decreasing New Investment Outlay Through Modernization by Installments

**With sustained business improvement, many plants are feeling the need to modernize their power services. Often this course is impossible, however, where the new investment required is not readily available. The accompanying article, based on a group of analyses prepared by a prominent industrial engineer who prefers to remain anonymous, suggests and illustrates a method of modernization by installments whereby each succeeding increment of expense for new equipment is met by the savings resulting from the preceding investment. The method is one which will recommend itself to large and small companies alike.—Editor.**

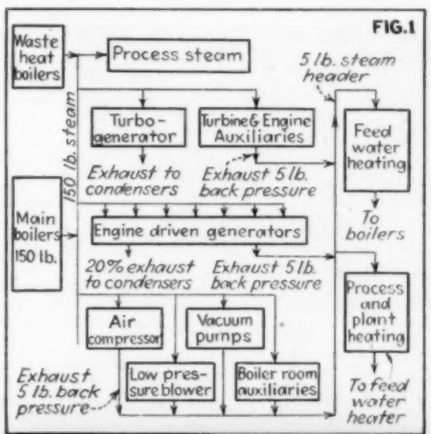
BOTH STEAM GENERATING and turbine equipment have been so much improved during the last seven years that many process industries have been looking closely at their power costs, convinced of the economic soundness of revamping their complete power generation and distribution systems. In many cases, however, the obstacle of financing the complete modernization is too great to surmount after the poor profits of the last five years and only a means of modernization by installments over a period of time is feasible.

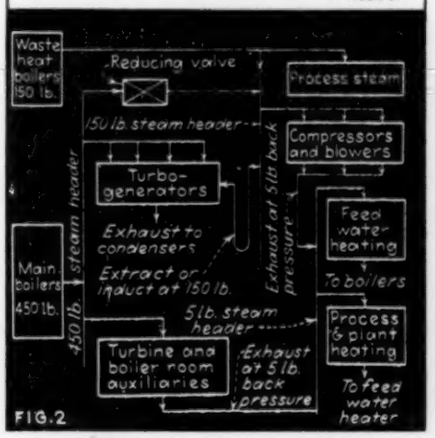
Bearing in mind that the ultimate aim is complete heat balance for the plant if that is possible, an improved installation can usually be designed which need not be put into operation all at once, but can be constructed in two or more installments, using part of the old equipment to carry on those functions which are later to be improved with further new equipment. By this means each succeeding step in the modernization will help in creating a reserve fund to take care of the next step.

By way of illustration, three plants which have adopted or are planning to adopt this scheme have been selected and the large operating savings shown by calculated data and charts.

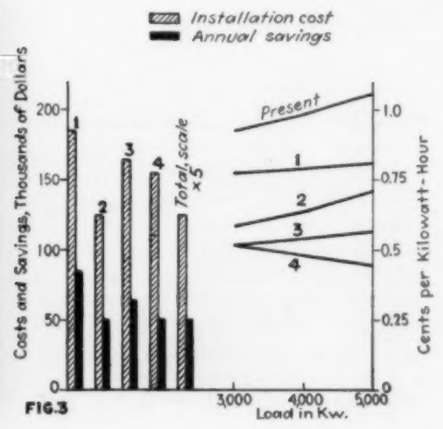
In Fig. 1, a plant is shown schematically which has a demand for process steam at 150 lb. and 5 lb. Part of this steam is generated in waste heat boilers, the amount each hour varying from zero to 50 per cent of the total requirements. The power demand, which averages from 4,000 to 5,000 kw., peaks at 6,000 kw., and steam is required for steam driven compressors and vacuum pumps. This load is generated by two turbo-generators and seven steam-engine-driven generators, steam being supplied from the 150 lb. steam header.

A study of this plant indicated that all engine-driven units should be eliminated and steam generated at higher pressure. The revamped plant, diagrammed in Fig. 2, would require new main boilers, means for auxiliary firing




**Figs. 1-3—Installment modernization of the process power services shown diagrammatically in Fig. 1, resulting in the final layout given in Fig. 2, produced unit and annual savings as charted for the four steps in Fig. 3, which also shows the investment cost of each of the modernization steps. New higher pressure boilers were required, together with new turbines, new turbo-generators and means for auxiliary firing of the waste heat boilers. After a relatively small initial investment, sufficient savings resulted to permit completing the program in four years.**

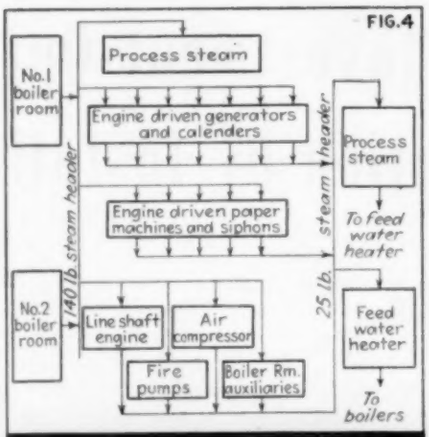


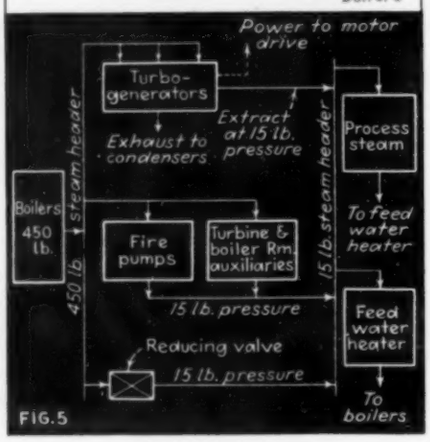
ing of the waste heat boilers, and the installation of mixed pressure turbo-generators. The total capital investment for this modernization was estimated at $625,000 which would be recovered in three years through savings.

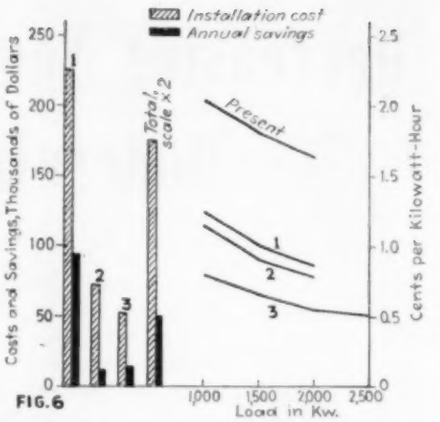
In order to avoid the large initial investment required for the complete program, the following plan was adopted to permit an immediate start.

*Step 1*—Since the two generators of the old turbo-generators were in good condition, new turbines and surface condensers were installed operating from the old 150 lb. steam header. The turbines were designed for change-over at a later date for operation on 450 lb. pressure, extracting and inducting at 150 lb. pressure. The circulating water system was redesigned, new feeder panels were installed and the switchboard was relocated, using old equipment as far as possible; cost, $185,000.

*Step 2*—The engine generators were removed, providing room for three turbo-generators, one of which was installed; cost, $125,000.




**Figs. 4-6—Diagrams illustrating "before and after" in a paper mill power installation appear in Figs. 4 and 5 respectively. Fig. 6 portrays unit and annual power costs at each stage in the modernization, also giving investment costs. Whereas part of the power must be purchased with the original plant, the modern boilers and turbo-generators in the improved layout will permit the byproduct generation of all power, with a reduction in steam demand of 12 per cent, and sizable annual savings. Replacement of engine drive with group motor drive is a feature.**

*Step 3*—450-lb. boilers were installed and the turbo-generator changed over to operate at 450 lb.; cost, $165,000.

*Step 4*—Two additional turbo-generators were installed, eliminating the use of all engines; cost, $155,000.

In preparing Table I and the curves of Fig. 3, the total cost of coal and operating was based on the average cost over the preceding five years, while the operating personnel cost was assumed to be constant. These data illustrate the recovery of capital investment in each step of the program.

**Table I—Total and Unit Costs for Plant of Figs. 1 and 2**

| Average Load, Kw. | Annual Power, Kw.-Hr. | Steam, 1,000 Lb. | Coal and Operating Cost, Dollars | Cost per Kw.-Hr., Cents |
|---|---|---|---|---|
| **Present** | | | | |
| 3,000 | 26,100,000 | 765,000 | 241,250 | 0.924 |
| 4,000 | 34,800,000 | 1,180,000 | 345,000 | 0.99 |
| 5,000 | 43,500,000 | 1,645,000 | 461,250 | 1.06 |
| **Step 1 — Two New Turbo-Generators Installed on Present Boilers** | | | | |
| 3,000 | 26,100,000 | 608,000 | 202,000 | 0.774 |
| 4,000 | 34,800,000 | 905,000 | 276,250 | 0.792 |
| 5,000 | 43,500,000 | 1,218,000 | 354,500 | 0.81 |
| **Step 2 — Third Turbo-Generator Installed** | | | | |
| 3,000 | 26,100,000 | 417,000 | 154,250 | 0.591 |
| 4,000 | 34,800,000 | 694,000 | 223,500 | 0.641 |
| 5,000 | 43,500,000 | 1,045,000 | 311,250 | 0.716 |
| **Step 3 — 400-lb. Boilers Installed** | | | | |
| 3,000 | 26,100,000 | 346,000 | 136,500 | 0.524 |
| 4,000 | 34,800,000 | 556,000 | 189,000 | 0.543 |
| 5,000 | 43,500,000 | 786,000 | 246,500 | 0.567 |
| **Step 4 — Installation of Turbo-Generators Completed** | | | | |
| 3,000 | 26,100,000 | 346,000 | 136,500 | 0.524 |
| 4,000 | 34,800,000 | 465,000 | 166,250 | 0.478 |
| 5,000 | 43,500,000 | 580,000 | 195,000 | 0.448 |

**Table II—Total and Unit Costs for Plant of Figs. 4 and 5**

| Average Load, Kw. | Annual Power, Kw.-Hr. | Steam, 1,000 Lb. | Coal and Operating Cost, Dollars | Cost per Kw.-Hr., Cents |
|---|---|---|---|---|
| **Present** | | | | |
| 1,000 | 6,500,000 | 572,000 | 134,500 | 2.07 |
| 1,500 | 9,600,000 | 770,000 | 174,000 | 1.81 |
| 2,000 | 13,000,000 | 960,000 | 212,000 | 1.63 |
| **Step 1 — New Boilers and Two Turbo-Generators Installed** | | | | |
| 1,000 | 6,500,000 | 308,000 | 81,600 | 1.256 |
| 1,500 | 9,600,000 | 396,000 | 99,200 | 1.025 |
| 2,000 | 13,000,000 | 456,000 | 111,200 | 0.86 |
| **Step 2 — Motor Drive of Paper Machines and Calenders Installed** | | | | |
| 1,000 | 6,500,000 | 276,000 | 75,200 | 1.155 |
| 1,500 | 9,600,000 | 334,000 | 86,800 | 0.904 |
| 2,000 | 13,000,000 | 408,000 | 101,600 | 0.782 |
| **Step 3 — Third Turbo-Generator Installed; Line Shaft Engine Removed** | | | | |
| 1,000 | 6,500,000 | 160,000 | 52,000 | 0.800 |
| 1,500 | 9,600,000 | 216,000 | 63,200 | 0.658 |
| 2,000 | 13,000,000 | 276,000 | 75,200 | 0.579 |
| 2,500 | 16,800,000 | 330,000 | 86,000 | 0.512 |

**Table III—Total and Unit Costs for Plant of Figs. 8 and 9**

| Average Load, Kw. | Annual Power, Kw.-Hr. | Steam, 1,000 Lb. | Coal and Operating Cost, Dollars | Cost per Kw.-Hr., Cents |
|---|---|---|---|---|
| **Present** | | | | |
| 1,000 | 6,500,000 | 410,000 | 145,000 | 2.23 |
| 1,500 | 9,600,000 | 540,000 | 162,000 | 1.68 |
| 2,000 | 13,000,000 | 680,000 | 206,000 | 1.58 |
| **Step 1 — New Boilers and One Turbo-Generator Installed** | | | | |
| 1,000 | 6,500,000 | 260,000 | 78,200 | 1.19 |
| 1,500 | 9,600,000 | 332,000 | 101,000 | 1.06 |
| 2,000 | 13,000,000 | 390,000 | 119,000 | 0.92 |
| **Step 2 — Second Turbo-Generator Installed and Engine Replaced With Motor Drive** | | | | |
| 1,000 | 6,500,000 | 162,000 | 54,000 | 0.834 |
| 1,500 | 9,600,000 | 230,000 | 65,400 | 0.68 |
| 2,000 | 13,000,000 | 276,000 | 82,400 | 0.634 |

The gradual reduction in power cost for each step of the program is shown strikingly in Fig. 3 which also shows investment increments and the annual savings resulting from each step. For example, annual savings of nearly $90,000 resulting from Step 1 provided a sinking fund for Step 2 which could be completed at the end of the second year. By the end of the third year, the sinking fund permitted installation of Steps 3 and 4.

A second plant, a paper mill which arranged to modernize by this method, operates an average of 6,000 hours per year. The original plant is shown schematically in Fig. 4 and the modernized plant in Fig. 5. In the original plant, a portion of the power required is generated while the balance is purchased. However, with modern boilers and turbo-generators, the power demand can be generated incidental to the production of process steam and the present steam demand can be reduced by about 12 per cent. Since the present boilers and engines are more than 20 years old, maintenance is costly and the scattered location of boiler rooms and engines adversely affects operating costs.

Installation of a modern power plant and changing all of the engine-driven units over to group motor drive would require a minimum new capitalization of $350,000. Use of individual motor drive would be somewhat more costly. The capital investment in the modernized plant could be recovered within three to four years without taking credit for reduced operating and maintenance costs, but simply crediting savings in coal and power. The modernization was planned to be carried out in three steps as follows:

*Step 1*—Install new boilers and two turbo-generators, the turbines to be non-condensing and of the extraction type; cost, $225,000.

*Step 2*—Install motor drive to paper machines and calenders; cost $73,000.

*Step 3*—Install third turbo-generator. Remove engine-driven line shaft and replace with motors arranged for group drive; cost $52,000.

The savings possible with this particular modernization are shown in Table II and in the curves of Fig. 6. By allowing the savings of Step 1 of this project to accumulate for two years, sufficient funds would be available to complete the modernization, thereby reducing the present operating cost of the paper mill by more than $90,000 per year.

## Process Steam

In the third plant, sufficient process steam demand exists to permit generation of all power, provided that steam generating equipment is installed for 450 lb. boiler pressure and that additional process drying equipment is supplied to permit reducing the process steam pressure from 60 to 25 lb. The advantages of bleeding process steam at this lower pressure are illustrated by the chart shown in Fig. 7.

In the present plant, both turbo-generators and engines are used, as shown schematically in Fig. 8. The new plant would require new boilers and substitute an additional turbo-generator for the engines, as shown in Fig. 9. The total cost, estimated at $250,000, could be covered in two steps so as to reduce the initial expenditure. These are as follows:

*Step 1*—Install new boilers, one turbo-generator and additional drying equipment, estimated cost, $150,000.

*Step 2*—Install motor drive to replace present engines; also the second new, turbo-generator; estimated cost, $100,000.

As will be evident from the data of Table III and Fig. 10, two years' accumulation of the savings from the first step would furnish sufficient funds to complete the program, resulting in a final saving of $80,000 per year compared with present operating costs of the plant.

These several examples are taken from a variety of process industries, tending to show that the advantages of modernization by installments are generally applicable to all plants having a process steam demand which permits of overall heat balance. It has been shown that only a moderate initial financial outlay is necessary in converting any such plant with obsolete equipment to one that is economically sound and up to date.

**Figs. 7-10—Advantages of a lower process steam bleed pressure are shown in Fig. 7, while Figs. 8 and 9 diagram the present and proposed power services in a plant which plans to reduce process steam pressure, even though this will require additional drying equipment on account of the lower steam temperature. Fig. 10 shows the unit power costs, annual savings and investment costs at each stage of the modernization. With new higher pressure boilers, new dryers and new turbo-generators to replace the present engines, annual savings of $80,000 are indicated.**

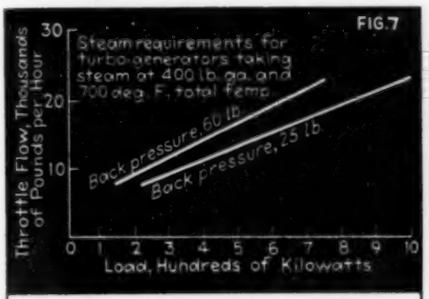
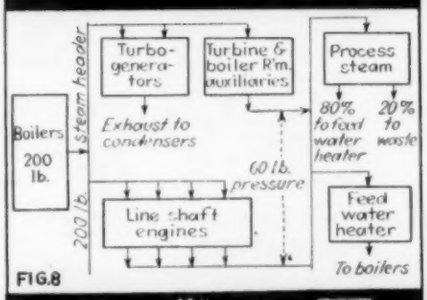
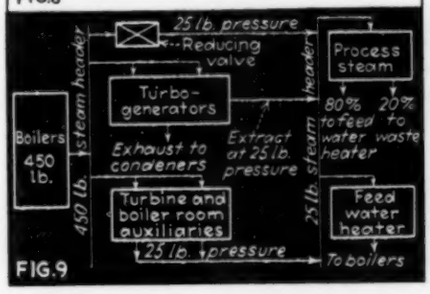
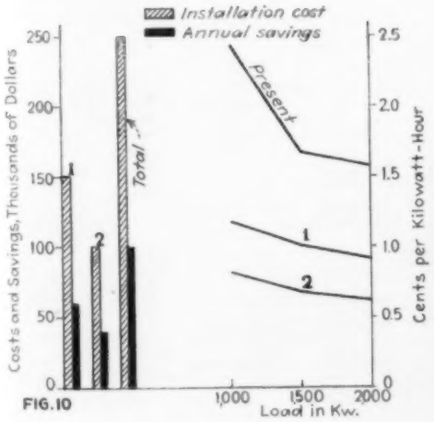


FIG.7
Steam requirements for turbo-generators taking steam at 400 lb. ga. and 700 deg. F. total temp.
Back pressure, 60 lb.
Back Pressure, 25 lb.
Throttle Flow, Thousands of Pounds per Hour
Load, Hundreds of Kilowatts



# Continued Progress in the PLASTIC INDUSTRY

## Supplements November, 1934, List of Plastic Products

This is a continuation of the list of trade names appearing in the August issue of *Chem. & Met.*, vol. 44, pp. 427–29. It was prepared by Alan F. Randolph, of the Plastics Department of E. I. du Pont de Nemours & Co., Arlington, N. J., with the cooperation of Dr. Max Forrer, of Manufacture d' Isolants et Objets Moules, Vitry-sur-Seine, France, and of Dr. Franz Pabst, editor of *Plastische Massen*, Berlin-Dahlem, Germany. It supplements the list which appeared in *Chem. & Met.*, Vol. 41, pp. 589–596. The following symbols and abbreviations are used:

* Item appeared in 1934 list; this is correct or amplified information

C Casein
CA Cellulose acetate
Ellis, "The Chemistry of Synthetic Resins," by Carlton Ellis (Reinhold, N. Y., 1935)
f Fabricator's trade name, not necessarily same as trade name of material used
l Laminated goods
m Molding compounds
P Packaging material
PF Phenol formaldehyde
PX Pyroxylin
s Safety glass
t Turnery material
UF Urea formaldehyde
x Sheets, rods, tubes
V Viscose

### M

| Name | Description | Manufacturer or Reference |
|---|---|---|
| **Maizite** | Plastic from corn gluten | American Maize Prods. Co., New York |
| ***Maizolith** | Plastic from corn cobs | Engineering Exp. Sta. Labs., Iowa State College, Iowa |
| **Marbloid** | CA | Speights Ltd., England |
| **Marbloid** | UF, m | Dai Nippon Celluloid Co., Osaka, Japan |
| **Marbo**, **Marbon** | Chlorinated rubber, etc. | Marbo Prods. Corp., Chicago |
| **Margolit** | Cold molded | Ver. Isolatorenwerke A.G., Berlin-Pankow, Germany |
| **Marmulit** | PF,f, UF, f | Marius Mulvad A/S, København, Denmark |
| **Marpressit** | PF, UF, paneling | Philips Industrial, London |
| **Marquis ware** | f | Commonwealth Mldg. Co., Ltd., Arncliffe, N.S.W., Australia |
| **Marvatex** | Syn. resin prods. | Paul C. Haas, Menden, Mich. |
| **Marvelyn** | Polystyrol denture | Marvelyn Dental Co. |
| **Matit** | PF, m | Ernst Maté, Wien |
| **Mayfair** | f | Harrison Bros., Birmingham, England |
| **Megacite** | | Brit. Television Supp. Co., Ltd., London |
| **Megohmo** | f | Waterbury Button & Mfg. Co., Waterbury, Conn. |
| **Mellit** | PF, m | J. Mellert, Bretten, Germany |
| **Melusite** | PF | Ellis 1403 |
| ***Membranit** | Alkyd resin | **Plastische Massen** 7 119 (1937) |
| **Mendelith** | PF, m | Radio H. Mende & Co., G.m.b.H., Dresden |
| **Merit** | PF, m | Gebr. Merten, Gummersbach, Germany |
| **Metrovick Traffolyte** | l, ornamental | Metropolitan-Vickers Elect. Co., Ltd., Manchester, Eng. |
| **Micabond** | | Continental-Diamond Fibre Co., Newark, Del. |
| ***Micanite** | Laminated mica...add | Micanite & Insulators Co., Ltd., London; Mica Insulator Co., New York |
| **Mico** | f | Mogadore Insulator Co., Mogadore, Ohio |
| **Microspec** | PF, l | General Inductance Co., London |
| **Milusite** | PF | Ellis 1403 |
| **Miolux** | Phosphorescent plastic | Mfrs. d'Isolants et Objets Moulés, Vitry-sur-Seine, France |
| **MIOM** | | |
| **Mioper** | Microporous ebonite | |
| **Mipolam** | Vinyl resin plastic | Venditor G.m.b.H., Troisdorf, Germany |
| **Mirasol** | Syn res | Carbogen Chem Co., Garwood, N. J. |
| **Mitex** | | Mitex A.G., Berlin |
| **Mixit** | PF, m, UF, m | Mix & Genest A.G., Berlin-Schöneburg, Germany |
| ***Moldacele** | Superseded by | Plastacele |
| **Moldigan** | | I. G. Farbenindustrie, Frankfurt am Main, Germany |
| **Moldrite** | UF, m | Montecatini, Milano, Italy |
| **Mold Wood** | Wood subst | Wood Amalgam Co., Bloomfield, N. J. |
| **Monarch** | UF, f | Moulded Prods. Ltd., Melbourne, Australia |
| **Monoid** | f | Atlas Mfg. Co., Ltd., England |
| **Monolith** | PF | Rev. gén. mat. plastiques 12 245 (1936) |
| **Moroid** | C | Morgan Ebonite Co., Manchester, Eng. |
| ***Mouldrite** | PF, m, s, l. UF, m, s, l. Benzyl cellulose, m | Mouldrite Ltd., London; Soc. Nobel Française, Paris |
| **Mowital** | Polyacetal | I.G. Farbenindustrie, Frankfurt am Main, Germany |
| **Myrac** | PF, s | Mitchell-Rand Mfg. Co., New York |
| **Mysorite** | PF, f | Govt. Electrical Factory, Bangalore, India |

### N

| Name | Description | Manufacturer or Reference |
|---|---|---|
| **Nadir** | Cellulose tape | Ozalid Co., Ltd. London |
| ***Nally** | f | Nally Ltd., Sidney, Australia |
| **Nameloid** | Decorative sheeting | Scott Bader & Co., London |
| **Naturin** | Sausage skin | Freudenberg, Wernheim, Germany |
| **Naturindarm** | From leather waste | **Plastische Massen** 7 119 (1937) |
| ***Neoformolit** | Oil, formaldehyde, sulph. acid | **Kunststoffe** 26 213 (1936) |
| **Neohecolite**, **Neohekolith** | Denture | |
| **Neolit** | PF, l | Neolitwerk A.G., Dessau, Germany |
| **Neoprene** | Synth. rubber, formerly DuPrene | E. I. du Pont de Nemours & Co., Wilmington, Del. |
| ***Neoresit** | add PF, t | Aug. Nowack A. G., Bautzen, Germany |
| **Nevillac** | Ale.-sol. res. | Neville Company Pittsburgh |
| **Nevillite** | Hydrocarbon res. | |
| **Nevindene** | Coumarone-indene resin | |
| **Niflammit** | | I. G. Farbenindustrie, Frankfurt am Main, Germany |
| **Nilcrodium** | PF, bitumen | Pritchett & Gold, London |
| **Nissho Kesho Ban** | PF, l | Nissholite Kogyo Co., Ltd., Kyoto, Japan |
| **Nitrocol** | Cell. ester with plasticizer, pigment | C. J. Osborn, New York |
| **Nixonite** | m | Nixon Nitration Works, East Nixon, N. J. |
| **Norbo** | PF, m | Bakelite Corp., New York |
| **Norit** | PF, m & cold molded | Chr. Geyer G.m.b.H., Nürnberg, Germany |
| ***Noveloid** | Benzyl cellulose, m | See Mouldrite |
| **Novex** | m, t | Imperial Chem. Industries, Ltd., London |
| ***Novite** | PF, m | See Mouldrite |
| **NPS** | Coumarone-indene resin | Neville Co., Pittsburgh |
| **Nuloid** | PF, s | Ellis 1405 |
| **NYH** | | New York-Hamburger Gummi-Waren Co., Hamburg |
| **Nyhatex** | l, paper | |
| **Nyhax** | l, cloth | |

### O

| Name | Description | Manufacturer or Reference |
|---|---|---|
| **Oasin** | | Schreyer & Co., Hannover, Germany |
| **Oil Stop** | Cashew nut polymer | Irvington Varnish & Insulator Co., Irvington, N. J. |
| **Olasol** | PF, s | Soc. Nobel Française, Paris |
| **Old Gold** | V, p | Sylvania Industrial Corp., Fredericksburg, Va. |
| **Olovine** | Vinyl res | Ellis 1405 |
| **Olymp** | | Adam Opel A.G., Rüsselsheim, Germany |
| ***Omegite** | PF, m | See Mouldrite |
| **Opel** | f | Adam Opel A.G., Rüsselsheim, Germany |
| **Oppanol** | | I. G. Farbenindustrie, Frankfurt am Main, Germany |
| **Orca** | Acrolein res | (France) **Kunststoffe** 27 16 (1937) |
| ***Osalith** | C | M. Oechsler, Ansbach, Germany |
| **Ozasol** | Px, etc | Kalle & Co., A.G., Wiesbaden-Biebrich, Germany |

### P

| Name | Description | Manufacturer or Reference |
|---|---|---|
| **Pandura** | PF, s | Paramet Chem. Corp. New York |
| ***Panelyte** | PF, l | Panelyte Co., New York |
| **Paradura** | PF, etc., s | Paramet Chem. Corp. New York |
| **Parafilm** | Heat-sealing sheeting | Menasha Prods. Co., Menasha, Wis. |
| **Paraloid** | | Paraloid Works, Inc., New York |
| **Paramet** | | Paramet Chemical Corp., New York |
| **Paranite** | Hose of Thiokol | Raybestos-Manhattan Inc., Passaic, N. J. |
| **Paranol** | PF, etc., s | Paramet Chem. Corp., New York |
| **Paraplex** | Resin | Resinous Prods. & Chem. Co., Philadelphia |
| **Parkesine**, **Parkesite** | PX | (Obsolete) names used by Alex. Parkes, England, 1865 |
| **Pascolin** | See Fiber Diamond | |
| **Pazolin** | l | Micanite & Insulators Co., Ltd., London |
| **PB** | f | Punfield & Barstow, London |
| **Pehalit** | PF,m, UF, m, f | Presswerk G.m.b.H., Herscheid, Germany |
| **Pejatit** | PF, m | Paul Jatow, Dodendorf, Germany |
| ***Pekaglas** | Vinyl resin safety glass | Verbundglasgesellschaft, Berlin |
| **Pentex** | Celluloid and paper | Celluloid Printers Ltd., Surbiton, Surrey, England |

| Name | Description | Manufacturer or Reference |
|---|---|---|
| Perdurene | Syn. rubber | I. G. Farbenindustrie, Frankfurt am Main, Germany |
| Pergut | Chlorinated rubber | |
| Perliane | CA, x, f | Soc. Usines Chim. Rhône-Poulenc, Paris |
| Perloid | Syn. res. | Dr. I. Perl & Co., A.G., Berlin |
| Perloid | PX, Pearl sheeting | E. Bader & Co., London |
| Perloid-Perlopal | | Celluloid Verkaufsges. G.m.b.H., Berlin |
| Permanit | PF, m | E. Wipperman, Halver, Westf., Germany |
| Permaphane | Generic name (Germany) for luminous paints cont. strontium sulphide | |
| *Permaplastic | t, m | Permastic Ltd., Weybridge, Surrey, England |
| Perspex | Methyl methacrylate resin, t | Imperial Chemical Industries, Ltd., London |
| Pete | PF | Peter Temming A.G., Glückstadt, Germany |
| Petrex | Terpinine-maleic anh. res. | Hercules Powder Co., Wilmington, Del. |
| Petrolac | Syn. res. | Advance Solvents & Chem. Corp., New York |
| *Phenac | Modified PF | American Cyanamid & Chem. Corp., New York |
| Phenalin | PF, t | E. I. du Pont de Nemours & Co., Arlington, N. J. |
| Phenoform | PF | (U.S.A.) Ellis 1407 |
| Phenolia | PF, t | Modern Plastics 6 48 (1934) |
| Phenopal | | Dr. Kurt Albert, G.m.b.H., Amöneburg, Germany |
| Phenoplasts | Generic term for phenol-formaldehyde resins | |
| Philipress | I (?) | N. V. Philips Gloeilampenfabrieken, Eindhoven, Netherlands |
| Philips | Plastics and f | Philips G.m.b.H., Berlin |
| Philitax | I | N. V. Philips Gloeilampenfabrieken, Eindhoven, Netherlands |
| *Philite | PF, UF, m, I, f | |
| Philitext | I | Philips Lamps Ltd., London |
| Phoenix | | Phoenix A.G., Harburg-Wilhelmsburg, Germany |
| Phoenixite | Special celluloids | Dai Nippon Celluloid Co., Ltd., Osaka, Japan |
| Pierretone | PX | Celluloid Corp., Newark, N. J. |
| Pirolite | PF | Montecatini, Milano, Italy |
| *PK | See Pekaglas | |
| *Plaskon | UF, m | Plaskon Co., Inc., Toledo, Ohio |
| Plasmic | Syn. res. | Plasmic Ltd., London |
| Plasoleum | Adhes. caulking | Revertex Corp. of America, New York |
| *Plastacele | CA, x, m | E. I. du Pont de Nemours & Co., Arlington, N. J. |
| Plastoid | Acrylic res. for modelling | Anatomischer Anz. 81, Dec. 3, 1935 |
| *Plax | Rubber-cellulose | Ellis 1408 |
| Plexiflm | | Röhm u. Haas, Darmstadt, Germany |
| Plexigal | resins | |
| Plexiglas | t (acrylic) | |
| Plexiglass | t (acrylic) | Röhm & Haas Co., Inc., Philadelphia |
| *Plexigum | m | |
| Plexisol | | |
| Plexit | Acrylic res. dispersions | Deutsche Amphibolinwerke, Oberrenstadt, Darmstadt, Germany |
| Plexitol | Emuls. polymethyl acrylate | I. G. Farbenindustrie, Frankfurt am Main, Germany |
| Plextol | Resins | Röhm u. Haas, Darmstadt, Germany |
| Pliofilm | P } rubber | Goodyear Tire and |
| Pliolite | S } deriv. | Rubber Co., Akron, Ohio |
| Pliopal | PF, t, f | Dr. Kurt Albert, Wiesbaden, Germany |
| Pliorit | PF, t, f | Albert Products Ltd., Erith, Kent, England |
| Plioston | m, t, f | |
| Pluteite | PF, m | Montecatini, Milano, Italy |
| Plynalith | | Isaac Frenkel, Paris |
| Plyrock | I | Plyrock Ltd., London |
| Polaroid | Polarizing sheeting | Land-Wheelwright Labs. Boston Sheet Polarizer Co., Inc., Union City, N. J. Polaroid Products, London |
| Pola Screen | Polarizing sheeting | Ind. Eng. Chem., news ed. 15 33 (1937) |
| Poldit | PF, m, UF, m | L. Kostal, Lüdenscheid, Germany |
| Polight | Polarising sheeting | Polarized Lights, Inc., Newark, N. J. |
| *Pollopas | UF, m, t, I | add Beetle Prods. Co., Ltd., London |
| Polyanthus | f | James Scott Mfg. Co., London |
| Polyfil | | Chem. Forschungsges. G.m.b.H., München |
| Polym | PF | Ellis Foster Co., Montclair, N. J. |
| Polynit | Polybutadiene resin | I. G. Farbenindustrie, Frankfurt am Main, Germany |
| Polystal | adhesives | |
| Polysti | | |
| Polyviol | Polyvinyl alcohol | Dr. Alex. Wacker G.m.b.H., München |
| Pontalite | Methacrylate resin; see Lucite | |
| *Porcedent | Px denture | |
| Porcellanite | C | Soc. Charraud Ruel, France |
| Porzellanite | C | |
| Povimal | Polyvinyl maleate | I. G. Farbenindustrie, Frankfurt am Main, Germany |
| Premix | I | B. S. & W. Witheley, Ltd. |
| Prenite | Neoprene, f | B. F. Goodrich Co., Akron, Ohio |
| Pressharz | PF, m (transparent) | Dr. Kurt Albert, Wiesbaden, Germany |
| Press Mass | CA, m | American British Chem. Supplies, Inc., New York |
| Pressmater | PF, m | Robt. Anke, Oelsnitz i. Vogtl., Germany |
| Presspanzer | PF, m | Paul Jordan, Berlin-Steglitz, Germany |
| Primophan | V, p | |
| Protecto | CA, box toe | Celluloid Corp., Newark, N. J. |
| *Protectoid | CA, film, f, x | |
| *Protex | Safety glass | add Miroiterie Le Lion, Antwerp |
| Protodur | Polyvinyl resin | Siemens-Schuckert-Werke A.G., Berlin-Siemensstadt, Germany |
| Protolit | PF, m | Oesterreichische Siemens-Schuckert-Werke, Wien |
| Prystal | PF, t | Catalin Corp. of America, New York |
| *Pyralin | PX | E. I. du Pont de Nemours & Co., Arlington, N. J. Canadian Industries Ltd., Montreal |
| Pyrido Rubber | Polyacrolein-methylamine | Ellis 1409 |

## R

| Name | Description | Manufacturer or Reference |
|---|---|---|
| Radiaco | Insulator | Soc. anon. l'Electro-Isolant, Paris |
| Radifix | Rapeseed oil-sulphur chloride | Ellis 1409 |
| Radiolite | I | Fabr. Suisse d'Isolants, Breitenbach, Switzerland |
| Radio X | PF, m | Montecatini, Milano, Italy |
| Rakynol | PF, m, s, etc. | Lembach & Schleicher G.m.b.H., Wiesbaden, Germany |
| Rakyt | PF, t | |
| Ralotext | PF, m | H. Römmler A.G., Berlin-Spremberg, Germany |
| RDT Silver | Caulking material | Rüger & Mallon, Berlin |
| *Reflite | PF, m | Montecatini, Milano, Italy |
| *Repelit | PF, I | Siemens-Schuckert-Werke A.G., Berlin-Siemensstadt, Germany |
| Resart | Syn. res. | Resart Ges. Franke & Co., Hamburg |
| Reseneoplast | Alkyd | Ellis 1409 |
| Resibond | PF, I | Bakelite Ltd., London |
| Resiflim | PF, I | |
| Resiform | PF, m | Robt. Bosch A.G., Stuttgart-Feuerbach, Germany |
| Resinofil | PF, m | Dr. F. Raschig, G.m.b.H., Ludwigshafen, Germany |
| Resistant E | Cement-asbestos | Plastische Massen 7 114 (1937) |
| Resisto | Box toe | Celluloid Corp., Newark, N. J. |
| Resisto | Insulation | Tuco Prods. Corp., New York |
| Resistol | | Ellis 1410 |
| Resit | Generic name for phenol-formaldehyde resin in "C" stage | |
| Resitol | Generic name for phenol-formaldehyde resin in "B" stage | |
| Resol | Generic name for phenol-formaldehyde resin in "A" stage | |
| Resophene | | Résines et Vernis Artificiels, Paris |
| Respon | | Reso Prods. Co. |
| Resphan | | |
| Resovyl | Syn. res. | Etabls. Kuhlmann, Paris |
| Resweld | I | Veneercraft Ltd., London |
| Reugalit | f | Reuschenberg G.m.b.H. Leverkusen-Küppersteg, Germany |
| *Revolite | Cloth impreg. with PF | Atlas Powder Co., Stamford, Conn. |
| Rex | Records | Crystalate Gramophone Record Co., Ltd., London |
| Rex | f | Mfrs. d'Isolants et Objets Moulés, Vitry sur Seine, France |
| Rexol | Polystyrene, m | |
| *Reynolite | f | Reynolds Moulded Plastics, Inc., Jackson, Mich. |
| Reynomold | f | |
| Reziwood | Laminated wood | I. F. Laucks Inc., Seattle, Wash. |
| Rhode | CA, sheeting and f | Soc. Usines Chim. Rhône-Poulenc, Paris |
| Rhodopale | CA | |
| Rhoflax | Coating for fabrics | Röhm & Haas, Philadelphia |
| Rhonite | Syn. res. | |
| Rhoplex | Resin soln. | |
| Rhoptika | CA, f | Soc. Usines Chim. Rhone-Poulenc, Paris |
| Rhosilie | CA & f | |
| *Richelain | UF, f | Richardson Co., Melrose Park, Ill. |
| Roka | PF, m | Robt. Karst, Berlin |
| Ronilla L | Polystrol | Farbe u. Lack 633 (1936) |
| Ronyx | Protein plastics | Resinox Corp., New York |
| Ros | PF, m | Römmler & Schlumann, Berlin |
| Rosit | PF, m | Müller & Ros., Coburg, Germany |
| Rubbone | Rubber resin | Rubber Chem. Tech. 8 624 (1935) |
| Rubprene | Neoprene, f | Firestone Tire and Rubber Co., Akron, Ohio |
| Rubtex | Molded hard rubber | Richardson Co., Melrose Park, Ill. |
| Rulit | Cold-molded | Elektrotechnische Fabrik G.m.b.H., Bebra, Germany |

## S

| Name | Description | Manufacturer or Reference |
|---|---|---|
| Safeway Cord | CA, p | Safeway Products Corp., New York |
| Saf-T-Loid | CA | Parfait Powder Puff Co., Inc., Chicago |
| Saligenin | Generic name for a type of PF resin (Ellis 1412) | |
| Saliretin | Generic name for a type of PF resin (Ellis 1412) | |
| Santolite | Toluene-sulphonamide res. | Monsanto Chemical Co., St. Louis |
| Santo-resin | Syn. resins | |
| Satolite | CA | Dr. Sato, Japan |
| Scarab | UF, m | Beetle Prods. Co., Ltd., London |
| *Schellit | t | Etabls. Kuhlmann, Paris |
| Schreisignal | f | Deutiv G.m.b.H., Berlin |
| Schulit | PF, m | Max Schulze, Meissen, Sax., Germany |
| SDO | Synth. drying oil | E. I. du Pont de Nemours & Co., Wilmington, Del. |
| Sekolit | PF, m | Seckelmann & Co., Lüdenscheid, Germany |
| Selenite | C | (England) (Ellis 1412) |
| Semtex | Rubber latex plastics | New Prods. Digest 2 1184 (1936) |
| *Shallorite | CA | Shallorite Mfg. Co., New York |
| Sheentec | | Tennessee Eastman Corp., Kingsport, Tenn. |
| Shell-Pil | Lamin. cellulose sheeting | Shellmar Products Co., Chicago |
| Sieco | Syn. res. | Siemon Co., Bridgeport, Conn. |
| Sigla | SG with Plexigum | Sicherheits G.m.b.H., Kundendorf, Silesia, Germany |
| Silberschlauch | Polyvinyl alcohol | Plastische Massen 6 424 (1936) |
| Siluminit 4. | Bituminous | Plastische Massen 7 114 (1937) |
| Siluminit 5. | Cement | |
| Siluminit 6. | Asbestos-cement | |
| Silvaplana | Gelatine film | |
| Sipa | Insulator | Plastische Massen 7 3 (1937) |
| Solugum | Syn. res. | Soluol Corp., Providence, R. I. |
| Sovprene | Synthetic rubber | (U.S.S.R.) Rubber Chem. Tech. 9 382–408 (1936) |
| Spaulding | PF, f | Spaulding Fibre Co., Tonawanda, N. Y. |
| Spontex | Artif. sponge | Sponcel Ltd., Bromley, Kent, England |
| Stabol | Ethyl acrylate | Allgem. Elektr. Ges., Berlin |

| Name | Description | Manufacturer or Reference |
|---|---|---|
| **Stabsit** | Syn. res. | Soc. Grandseigneur, Perreux, France |
| **Staybelite** | Rosin substitute | Hercules Powder Co., Wilmington, Del. |
| **Sterling** | f. | Singer Thermoplastic Prods., Ltd., London |
| **Sterofil** | | Chem. Forschungsges. G.m.b.H., München |
| **Stoniflex** | Bituminous | D. Anderson & Son Ltd., Manchester, England |
| **Stovolite** | PF. | (U.S.S.R.) **Rev. gén. matières plastiques 12 84 (1936)** |
| **Styroflex** | Polystyrol | Norddeutsche Seekabelwerke A.G., Oldenburg, Germany |
| **Styrosets** | | I. G. Farbenindustrie, Frankfurt am Main, Germany |
| **Sucrolite** | Phenol-sugar | **Plastische Massen 6 31, 288 (1936)** |
| **Sundora** | CA | E. I. du Pont de Nemours & Co., Arlington, N. J. |
| **Sunex** | SG | Sunex Säkerhets Glass A.B., Stockholm |
| **Superlithe** | PF, m | Superlithe Corp., New Brunswick, N. J. |
| **Super-Mikanit** | | Allgem. Elektr. Ges., Berlin |
| **Supralit** | PF, m | Isolierpress-u. Porzellanfabrik G.m.b.H., Lüdenscheid, Germany |
| **Supra-Pressstoff** | | Allgem. Elektr. Ges., Berlin |
| **Syphcase** | Sausage casing | Sylvania Industrial Corp., Fredericksburg, Va. |
| **Syphgrass** | Artif. grass | |
| **Syphguard** | V, G | |
| **Syphwool** | V | |
| ***Synplas** | I. | Synplas Ltd., London |
| **Syntellac** | Acetaldehyde condensate | Ellis 1414 |
| **Synthofil** | V, f. | Chem. Forschungsges. P.m.b.H., München |
| **Syvolith** | C. | |

## T

| | | |
|---|---|---|
| **TC** | Syn. res. | Advance Solvents and Chem. Corp., New York |
| **Teasit** | | Paul Teich, Berlin |
| **Tec** | CA, m | Tennessee Eastman Corp., Kingsport, Tenn. |
| **Tee-pak** | V, P. | Transparent Package Co., Chicago |
| **Tegit** | Cold-molded | Garfield Mfg. Co., Garfield, N. J. |
| **Tego** | PF, resin film for adhesive | Resinous Prods. & Chem. Co., Inc., Philadelphia |
| **Tegofan** | Chlorinated rubber | Scott Bader & Co., Ltd., London |
| **Tegofilm** | Film for adhesive | |
| **Teka** | PF, m, UF, m. | T. Krigeloh & Co., Dahlerbrück, Germany |
| **Tekanit** | m | **Kunststoffe 26** 39 (1936) |
| **Telac** | | J. H. Tucker & Co., Ltd., Birmingham, England |
| **Telacite** | PF, m | |
| ***Tenacit X** | Cement-asbestos | Allgem. Elektr. Ges., Berlin |
| ***Tenacit Z** | Lead borate-mica | |
| **Tentelite** | f. | Albert Schulte Söhne A.G., Tente, Rhnld., Germany |
| ***Tepperite** | Rubber derivative denture | U. S. Rubber Co., New York |
| **Terylite** | Vinyl res. sheeting | Union Carbide & Carbon Co., New York |
| **Textit** | f. | Cable Mfg. Co., Ltd., Bratislava, Czechoslovakia |
| **Textoil** | I. | General Electric Co., Schenectady, N. Y. |
| ***Textolite** | PF, m, l. | General Electric Co., Lynn, Mass. |
| ***Text-Tiles** | PF, UF | H. E. Ashdown Ltd., Birmingham, England |
| **Thegranit** | PF, m | Thega-Kontakt G.m.b.H., Berlin |
| **Theolite Standard** | f. | Soc. Officine Standard, Milano, Italy |
| **Thepolit** | PF, m | Porzellanfabr. Theo. Pohl, Schatztar, Czechoslovakia |
| **Thermoid** | Cold-molded | Technical Prods. Co., Pittsburgh |
| ***Thermolite** | Px denture | Thermolite Prods. Corp., Chicago |
| **Thermolux** | Diffusing SG | **New Prods. Digest 2** 1167 (1936) |
| **Thermoprene** | Rubber deriv. | B. F. Goodrich Co., Akron, Ohio |
| ***Thesi-** | PF | Presswerk A.G., Essen, Germany |
| ***Thesit-Textil** | PF, l. | |
| ***Thiokol** | Olefine polysulphide, x, m | Thiokol Corp., Yardville, N. J. |
| **Thormalan** | PF, m | B. Thormann, Berlin |
| **Thread-Weave** | Cellulose ribbon | Norcross, New York, Moulded Prods. Ltd., Melbourne, Australia |
| **Tigerware** | UF, f. | |
| **Toledoit** | PF, m | Ernst Bremicker, Kierspe-Bahnhof Germany |
| **Tolex** | | Cable Mfg. Co., Ltd., Bratislava, Czechoslovakia |
| **Tornalac** | Tornesit coating | Paper Makers Chem. Co., Kalamazoo, Mich. |
| **Tortoiloid** | PX, etc. | British Tortoiloid, Ltd., Leicester, England |
| **Trafford** | | **Modern Plastics 14**, Apr. 1937, p. 23 |
| **Trafforoil** | Syn. res. and fiber, for bearings | Metropolitan-Vickers Elect. Co., Ltd., London |
| **Trans-Kerit** | | **Kunststoffe 26** 211 (1936) |
| **Transpex** | m, f. | Transpex Ltd., London |
| **Transphilit** | f, m | N. V. Philips Gloeilampenfabrieken, Eindhoven, Netherlands |
| ***Trefoil** | PF, l. | Bakelite Ltd., London |
| **Tribestos** | Brake linings. | H. H. P. Trist & Co., Weston-super-Mare, England |
| **Tristbestos** | | |
| **Trolit BC** | Benzyl cellulose, m | Dynamit A.G., Troisdorf, Germany |
| **Tromalit** | m contg. metal pwdr. | Venditor G.m.b.H., Berlin |
| **Trosbestos** | Insulation | |
| **Tundes** | PF, m | Thiel & Schuschardt, Ruhla, Thür., Germany |
| **Turbonitin** | I. | Jaroslaws Erste Glimmerwaren Fabrik, Berlin-Weissensee, Germany |

## U

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| **Uanite** | I. | A. McEwan & Co. Ltd., Glasgow |
| **U-Cellon** | | Cellon-Werke G.m.b.H., Berlin-Charlottenburg, Germany |
| **Uformite** | UF, s. | Resinous Prods. & Chem. Co., Inc., Philadelphia |
| **Ultralit** | f. | Wm. Runge & Co., Köln |
| **Ultraruncolit** | f. | |
| **Ungaphon** | | Röhm u. Haas A.G., Darmstadt, Germany |
| **Unilite** | PF, m, f. | Union Chemical Industries Co., Hong Kong |
| **Uniplast** | PF, m | Universal Plastics Corp., New Brunswick, N. J. |
| ***Unyte** | UF, m | Plaskon Co., Inc., Toledo, Ohio |
| **Urazone** | UF, m | Soc. Belge de l'Azote, Ougrée, Belgium |
| **Urex** | UF, m | Mfre. d'Isolants et Objets Moulés, Vitry-sur-Seine, France |
| **Urox** | Syn. res. compds. | Ellis Laboratories, Montclair, N. J. |
| **Usprene** | Neoprene, f. | U. S. Rubber Prods., Inc., Passaic, N. J. |
| **Utex** | CA sheet & tape | H. D. Symons & Co., Ltd., Kingston Hill, Surrey, England |

## V

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| **Vanalite** | m | Vitalite Co., Ltd., London |
| **Vauwe** | PF, m | Vossloh-Werke G.m.b.H., Lüdenscheid, Germany |
| **Velos Marbeloid** | f. | Pitchford & Sykes Co., Ltd. |
| **Vetroloid** | CA sheet | British Celanese Ltd., London |
| ***Victrolac** | Sound records of Vinylite | R.C.A.-Victor, Camden, N. J. |
| ***Victron** | Polystrol | **add** Communication Prods., Inc., Jersey City, N. J. |
| **Vigopas** | PF, m | Dr. F. Raschig G.m.b.H., Ludwigshafen, Germany |
| **Vinal** | Vinyl res. for SG | Carbide & Carbon Chemicals Corp., New York |
| **Vinarol** | Polyvinyl alcohol | **V. D. I. Kunst-u. Pressstoffe 1** 10 (1937) |
| **Vinifol** | Igelit films & ribbons | I. G. Farbenindustrie, Frankfurt am Main, Germany |
| **Vinoflex** | Vinyl res. | |
| ***Vinnapas** | Polyvinyl acetate | Consortium für Elektrochemische Industrie, München, Germany |
| **Vinylite X** | Vinyl SG interlayer | Carbide & Carbon Chemicals Corp., New York |
| **Vinyloid** | finishes | |
| **Vinylseal** | sealing compd. | |
| ***Viscacelle** | V, P. | British Cellophane Ltd., London |
| **Viscoid** | f. | Viscose Dev. Co., Ltd., Bromley, Kent, England |
| **Viscolax** | Rubber-viscose yarn | **Silk & Rayon 9** 200 (1935) |
| **Viskanol** | Syn. res. | Standard Oil Development Co., New York |
| **Viskaps** | Bottle caps | Viscose Dev. Co., Ltd., Bromley, Kent, England |
| **Viskrings** | | |
| **Vispronal** | Polymerization prods. | Advance Solvents & Chem. Corp., New York |
| **Vistanex** | Hydrocarbon polymers | Standard Oil Co. of N. J., New York |
| **Vistra** | "Syn. wool" | I. G. Farbenindustrie, Frankfurt am Main, Germany |
| **Vito-mesh** | CA coated netting | Sears, Roebuck & Co., Chicago |
| **Vitrolux** | Anti-glare disc | W. & G. Baird Ltd., London |
| **Volcolit** | PF, m, f, | Volkenrath & Co., Schwenke, Westf., Germany |
| **Volkolit** | UF, m, f. | |
| **Vollmerit** | PF, m, UF, m. | Gebr. Vollmerhaus G.m.b.H., Lüdenscheid, Germany |
| **Vulcalok** | Resin & thermoprene | B.F.Goodrich Rubber Co., Akron, Ohio |
| ***Vulcoid** | Parchmentized cellulose & aniline resin | Continental-Diamond Fibre Co., Newark, Del. |
| **Vyncolite** | Insulation | Vynckier Frères & Co., Ghent |
| **Vynilene** | Dentures | Coe Laboratories, Inc., Chicago |

## W

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| ***Wacker-schellack** | Aldehyde resin | Wacker Ges., München, Germany |
| **Waloplast** | UF, m | Wolff & Co., Walsrode, Germany |
| **Wandrit** | | Dr. Martin Günther, Berlin |
| **Wecolit** | PF, m, UF, m. | Wester, Ebbinghaus & Co., Hanau, Germany |
| **Wecolit** | PF, s. | Wechsler & Co., Köln |
| **Wecranit** | PF, m. | Weber & Co., Krantchfeld, Germany |
| **Weculit** | PF, m. | Wilhelm Quante, Wuppertal-Elberfeld, Germany |
| **Wiccaprene** | Neoprene, f. | New York Rubber Co., Beacon, N. Y. |
| **Wiska** | PF, m. | Hoppmann & Mulsow, Hamburg |
| **Wonderware** | UF, f. | Moulded Prods. Ltd., Melbourne, Australia |

## X

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|---|---|---|
| ***Xylonite** | PX, x, f. | British Xylonite Co., Ltd., London |

## Z

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| ***Zelligluss** | German generic name for viscose packaging foil | |
| **Zellhorn** | German generic name for pyroxylin plastics | |
| **Zeterit** | Bituminous | Siemens-Schuckertwerke A.G., Berlin-Siemensstadt, Germany |
| **Zeynit** | PF, m. | Fr. Stauch, Unterrodach, Germany |
| **Zuckerith** | Syn. resin from sugar | Herbert Kurth, Schifferstadt, Germany |
| **Zuf** | Syn. res. | I. F. Laucks, Inc., Seattle, Wash. |
| **Zylonite** | f. | Celluloid Corp., Newark, N. J. |

# The Design of Bubble Cap Columns For Fractional Distillation

**In spite of the large amount of available scientific and experimental data on bubble cap columns, there are still many factors in their design which must be dealt with largely on the basis of past experience and simple technical reasoning. The author has drawn upon his own experience in the field and upon the experience of recognized authorities to discuss here some of the less formularized but none the less important considerations of column design.**

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SHARPLES SOLVENTS CORP.
WYANDOTTE, MICHIGAN

NUMEROUS DESIGNS of bubble cap column have been developed for distillation service, but all are based upon the same principles and are rooted in the fundamental idea of securing intimate contact between vapor and liquid. Hence in designing any column it is helpful to have at hand as many as possible of the data and detailed experience of others who have worked with similar if not identical problems.

In setting out to design a bubble cap column, the number of plates required is obviously of first importance. But since this subject has been adequately covered in chemical engineering textbooks, the present discussion will proceed immediately to the next important design step, namely, determination of column diameter. This factor, of course, is in turn dependent upon the vapor velocity to be used. The higher the vapor velocity, the smaller will be the column diameter required for a given through-put. Hence it is in the interest of low column cost to use the maximum allowable vapor velocity which conditions will permit. The opinion has been advanced that a higher vapor velocity is permissible in large diameter columns than in small columns. Also, it has been general experience that a column designed for high vapor velocity will operate at lower rates of through-put more satisfactorily than a column initially designed for a low vapor velocity will operate at higher rates of through-put.[6] Therefore, by designing a column for the maximum expected through-put and using high vapor velocities, reasonably good performance can be obtained if the column is operated at a lower rate.

The principal factor limiting allowable vapor velocity is entrainment of liquid in the rising vapor stream. It has been determined experimentally by Baker and Holbrook[7] that vapor velocity and plate spacing are the major factors influencing entrainment. Except in the case of liquids which foam easily, the kind of mixture being fractionated is of little consequence. The above experimenters also determined that in general, doubling the vapor velocity or reducing the plate spacing by half resulted in a tenfold increase in entrainment. Additional data indicated that a 300 per cent increase in reflux causes the entrainment to be doubled, as does also an increase of approximately 250 per cent in vapor velocity through the bubble cap slots.

Ashraf, Cubbage and Huntington[4] present interesting evidence to the effect that at low vapor velocities and relatively great plate spacings, entrainment is due to the action of the vapor carrying liquid droplets from plate to plate, while at higher vapor velocities and lesser plate spacings entrainment is due largely to actual splashing of liquid in rather large drops. Observations show a slow increase of entrainment with increase of vapor velocity up to certain points, after which the amount of entrainment increases rapidly. At this point the efficiency of fractionation will begin to drop rapidly. Hence, it is evident that for any given column there is an optimum vapor velocity where fractionating efficiency will be a maximum.

For simple bubble cap columns operating at atmospheric pressure, numerous references may be found which give the approximate allowable column vapor velocities met with in practice. Some of the recommended figures, together with their sources are as follows:

Badger and McCabe:[5] Ordinarily vapor velocities of 1.0 ft. per sec. are not exceeded.

Walker, Lewis and McAdams:[9] Superficial vapor velocities in well designed columns:—atmospheric pres-

sure, 1.0 to 1.3 ft. per sec.; high vacuum, 4.0 to 5.0 ft. per sec.

I. N. Beall:[6] Superficial column velocities vary from 1.5 to 4.0 ft. per sec. For a column 6 ft. in diameter a velocity of 2.0 to 3.0 ft. per sec. is suitable.

Carey:[5] The following values of superficial vapor velocities may be conservative but are within the range of good practice for petroleum columns not having baffles between the plates:

| Plate spacing (inches) | Vapor velocity (ft. per sec.) |
|---|---|
| 12 | 1.0 |
| 18 | 1.5 |
| 24 | 2.0 |
| 30 | 2.5 |

W. L. Nelson:[3] The following information is given as the allowable column vapor velocities established by practice in various petroleum refinery operations:

| Operation | Absolute pressure | Plate spacing (inches) | Vapor velocity (ft. per sec.) |
|---|---|---|---|
| Topping | 27 lb. per sq. in. | 22 | 2.0– 2.5 |
| Cracking | 40 lb. per sq. in. | 22 | 1.2– 1.7 |
| Other atmospheric distillation | 25 lb. per sq. in. | 22 | 2.0– 3.0* |
| Vacuum distillation | 30 mm. | 30 | 9.0–12.0 |
| Vacuum distillation | 90 mm. | 24 | 5.0– 8.0 |
| Stabilizer | 160 lb. per sq. in. | 18 | 1.7– 2.2 |
| Natural gasoline absorption | 50 lb. per sq. in. | 14 | 0.8– 1.2 |

* Values probably high.

It is possible to reduce the entrainment of liquid at high vapor velocities by the construction of suitably designed baffles between the plates. These act in such a manner that the liquid is separated from the vapor stream by impingement and change of direction of flow. Baffles increase the cost of a column considerably, however, and so are not generally used.

## Vapor-Liquid Contact

It is obviously true that for fractionating columns to operate efficiently, the contact between vapor and liquid must be as intimate as it is possible to obtain. The greater the intimacy, time and area of contact, the more nearly will equilibrium be approached between the vapor and liquid.

In a bubble plate column, contact between vapor and liquid is considered to occur in three stages: (1) vapor in the form of bubbles rising through the liquid; (2) vapor sweeping over the surface of the liquid; and (3) droplets of liquid or mist in the vapor space above the plate. The relative importance of these stages is difficult to determine, but it is generally conceded that most effective contact is obtained in the first and third. Hence the general practice of considering bubbling action as an important feature in bubble plate column design.

The design of the bubble cap is usually regarded as the controlling factor in obtaining good bubbling action. In order to obtain maximum intimacy and area of contact it is a requirement that bubble caps produce as large a number of very small bubbles as possible and that the bubbles be delivered in a uniform distribution over the entire plate. Also, the bubbles should be subjected to a maximum amount of distortion in their passage through the liquid in order to oppose the formation of a saturated film at their surface.[10] This bubble deformation and disturbance may best be obtained by spacing the caps at such a distance that the bubbles from one cap come violently in contact with the bubbles issuing from an adjacent cap.

Bubble caps with slotted edges are coming into more general use and offer possibilities of more accurate design than can be obtained with a serrated edge. The general agreement among authorities seems to be that the greatest number of small bubbles, and therefore the best plate efficiency, is obtained with the narrowest slot that can be used to give the required slot area per cap.[1,8,10]

## Shape of Bubble Cap Slots

The shape of the slot apparently has little effect upon the operation of a bubble column. Except at extremely low velocities, i.e., ½ ft. per sec. or less, the slot design does not affect the efficiency.[1] In a series of experiments reported by Kallam,[2] a number of different slot shapes having identical areas were tested for bubble producing ability. The slots tested included circular, rectangular and triangular shapes, and the same submergence and vapor conditions were used for each. The results indicated that the shape of the slot or bubble producing orifice had no effect upon the size of bubbles. The important requisite is that an individual slot should have an area as small as may practically be made.

The bubble cap slot area required per plate is determined by the desired vapor velocity through the slot and the maximum capacity of the column. With the column operating at maximum rate the slots should be wide open, but at lower rates of column through-put the liquid inside the bubble cap may not be depressed sufficiently to uncover the full opening of the slot. For triangular and rectangular slots, the amount of slot opening required for any rate of vapor flow can be determined b equations developed by Rogers and Thiele.[11]

Various ideas on proper bubble cap slot velocities have been advanced. Test results indicate that the efficiency of a column increases with the slot velocity until a point is reached where the flow of vapor forces the liquid off the plate. However, since this maximum velocity is much higher than any normal operating rate of flow, the slot velocity is limited only by the increase in pressure drop produced over the column and the characteristics of the liquid on the plate. In general, columns having the highest slot velocities are the most efficient. Allowable figures for these velocities are recommended by several authorities as follows: Badger and McCabe[8]—velocities of 10 ft. per sec. are good practice; Robinson[1]—the usual velocities are in the vicinity of 10 ft. per sec.: Beall[10]—vapor velocity is not less than 15 ft. per sec.

From this it may be concluded that the allowable slot velocity to be used in designing bubble caps varies from 10 to 20 ft. per sec. and is limited by the pressure drop and liquid characteristics.

## Effect of Slot Velocity

The effect of slot velocity on bubble formation has been investigated by Kallam,[2] who observed that at low vapor rates actual bubbles are formed by the slot, but at high velocities the vapor discharge from the slots forms a vortex with a minimum of bubbling effect. But, as previously stated, higher efficiencies are known to be obtained with the higher slot vapor velocities. Thus it appears that although high slot velocities give a poor bubbling action, they more than compensate for this by producing a more dense array of droplets above the sur-

face of the liquid. A decrease in the effectiveness of stage one of the vapor-liquid contact is offset by the largely increased effectiveness of stage three.

To prevent stratification of the liquid on a plate, and so that no liquid may flow across the plate without being agitated by and coming in contact with the vapor, slots in the bubble caps should be located as near the bottom of the liquid as possible. Slotted caps, as well as caps with serrated or notched lower edges, may be set directly on the bubble plate. Where caps are slotted, the lower edge of the slot should be as close as is commercially practical to the bottom edge of the cap. In operations where solids or viscous deposits may tend to clog the vapor slots, it is necessary that the bubble caps have serrated or notched edges and be supported so that the lower edge is a short distance above the top of the bubble plate.

The various shaped bubble caps have originated in an attempt to provide uniform distribution of bubble forming orifices over a plate and to prevent channeling of liquid or vapor during operation. Circular caps of from 3 to 7 in. in diameter are easily manufactured and have given satisfactory results in commercial operation. An objection lodged against the circular caps, however, is that there is some tendency for the vapor to follow the line of least resistance to flow and so cause channeling through the liquid on the plate. The vapor flow may start between two adjacent caps and once started will tend to continue to flow only at this point. With circular caps, this will occur at the slots on the circumferences of two adjacent caps where the distances between them is the shortest.[6] In an effort to avoid this, some designers have specified rectangular, triangular, hexagonal, or other shapes of caps.

The distance between two adjacent bubble caps is determined by the vapor velocity, the depth of the liquid and the characteristics of the liquid. The caps should be near enough together so that the bubbles issuing from one come into violent contact with the bubbles from another cap. This collision of the bubble stream should occur before the bubbles have assumed any appreciable vertical motion. In general practice, the spacing of the caps varies from 1 to 2 inches.[5]

## Vapor Risers or Chimneys

The vapor is conducted through a bubble plate and delivered to the inside of the bubble caps by means of vapor risers. These are generally of circular section and may be integral with the bubble cap or separate from it. In the same manner that the required slot area in the bubble cap is determined, the area necessary for vapor risers may be calculated by the use of an allowable vapor velocity. In general practice this velocity varies between the same approximate limits as does the velocity of the vapor through the bubble cap slots, i.e., from 10 to 20 ft. per sec. Since a part of the total pressure drop in a column may be attributed to the loss due to constriction of vapor flow at the vapor risers, these risers should have as large an area as it is reasonably possible to obtain. The total riser area per plate should amount to 10 to 20 per cent of the column cross-sectional area.[5] In the stripping section of a column, 10 per cent of the total column area is satisfactory, but in the rectifying section the riser area should run from 15 to 20 per cent of the column area.[6]

Although not entirely necessary, it is desirable that the height of the risers above the plate be equal to or slightly greater than the height of the weir or overflow pipe on the bubble plate. This will prevent liquids from running back down the vapor risers under conditions of normal operation.

## Depth and Flow of Liquid on Plate

Although there is not perfect agreement among authorities on the effect of depth of liquid on the bubble plate, this nevertheless is generally named as an important factor in the efficiency of column operation. As has already been stated, the longer the time of contact between the vapor and the liquid, the more readily will the equilibrium between the two be reached. And since the time that the liquid remains in the column may be lengthened by increasing the depth of the liquid on the plate, this implies that the greater the liquid depth, the longer is the time of contact and therefore the greater the efficiency toward establishing equilibrium conditions.[8] But, the statement has also been made that there is little advantage in allowing the bubbles to rise vertically through the liquid, and that therefore it is necessary to maintain the liquid level only a short distance above the top of the slots in the bubble caps.[1]

It has been found that a deep submergence of the slot, which requires considerable pressure drop to produce the flow of vapor, is not conducive to bubble formation.[2] With a low submergence, however, where but a low pressure drop produces flow, there is actual bubble formation. It therefore appears that a low liquid depth on the plates has the advantages of low pressure drop and ability to produce actual bubbles. There is also an opinion that a low operating liquid level on the plate increases the column capacity and provides for greater flexibility and efficiency at low rates of through-put.[6]

Apparently there is considerable variation in depths of liquid used in actual practice. One to 3 inches is recommended, although depths as great as 6 inches have been employed.[9] Particularly in columns operating under vacuum, where the pressure drop must be kept at a minimum, is it necessary to use lower submergences of the bubble cap slots. Columns operating under pressure are ordinarily not adversely effected by comparatively large pressure drops and in such columns a liquid level of 1 to 2 inches above the top of the bubble cap slots may be used.

It might be mentioned that it is not entirely necessary that the tops of the slots in the bubble caps be submerged by the static liquid level as established by the height of the overflow weir. It is only necessary that they be covered by the operating liquid level as determined by the weir crest. In most commercial operations, however, it seems logical that the static depth of the liquid on the plate should submerge the tops of the bubble cap slots. A submergence of approximately $\frac{1}{2}$ inch or more is desirable to provide for variations occurring in the assembling of a bubble plate.

An item of importance in the design of bubble plates is the manner in which the liquid flows on the plate. A winding path of flow, produced either by baffles or a judicious pattern of bubble cap location, or a combination of the two, is desirable. Relatively long, straight lanes between the bubble caps should be avoided because they promote channeling and surging of the liquid from one end of the lane to the other.

The simplest and most common type of bubble plate

is arranged for the cross flow of liquid, i.e., the liquid enters on one side of the plate and flows across to the opposite side. For columns not too large in diameter, this design gives satisfactory results in operation. The cross flow plate has been used successfully in columns as large as 4 to 6 ft. in diameter. However, in columns larger than this, it is exceedingly difficult to distribute the liquid uniformly across the entire plate. The hydraulic gradient set up across the plate may cause an unequal submergence of the bubble cap slots, and so cause the vapor to flow through the caps where it is opposed by the least liquid head. The caps on the opposite side of the plate will not be in operation. The actual number of caps in operation, however, will be determined by the vapor rate and not the liquid load. Kallam,[2] in commenting on this feature, states that the efficiencies of large diameter bubble plates are materially reduced because of the inactive portion of the plates. To prevent this one-sided operation, small column diameters and means for securing uniform slot submergences are recommended.

The design of large diameter bubble columns requires careful consideration of the means for distributing the liquid over the plate. Some of the schemes applied to secure the desired results are radial flow of liquid on the plate and an arrangement in which some of the features of both radial flow and cross flow are combined. In the radial flow column the down pipes are arranged to deliver the liquid to the center of the plate. The liquid then flows radially on the plate to a number of overflow weirs equally spaced about the outer edge. On plates where a combination of cross and radial flow is attempted, a number of down pipes are used to deliver the liquid at various points on the plate. Then by proper placing of the overflow weirs, a fairly uniform distribution of liquid is obtained through its relatively short travel across the plate. This design tends to overcome the difficulty of unequal slot submergences due to the hydraulic gradient. In addition to the above, several other plate designs have been developed in which the liquid is directed around the tray by means of baffling. These latter designs are not in general use, however, since the detailed construction increases column loss considerably.

## Weirs and Down Pipes

The depth of the liquid on a bubble plate is maintained by a weir. Over this the liquid flows into a down spout which in turn delivers it to the plate below. The variable factor for the weir is its length and for the down spout its area. More often than not, the upper end of the down spout functions as the weir, thus linking together the length of the weir and the area of the down spout in the consideration of their design. A variation in either can affect the capacity of the column, but which of the two factors is of greatest importance is a point upon which authorities are not in agreement.

Where the down spout projects above the bubble plate, the upper edge forms a weir and the weir length is the perimeter of the down spout. The cross section of the down spout may be circular, rectangular, or oval in shape. Another frequent design consists of partitioning off a portion of the bubble plate to form a reservoir or pocket having the shape of a segment of a circle. The down spouts are then connected into the pocket or by proper construction a down spout of the same shape as the pocket may be used. In either case the weir is then formed by the straight edge of the partition. A refinement in the straight weir is obtained by serrating the edge with V-notches, which presumably give a better liquid distribution and a more uniform flow of liquid.

The perimeter of the down spout, or the weir length, is considered more important than the cross-sectional area by Walker, Lewis and McAdams, and for this reason rectangular and oval shapes are given preference.[9] Carey states that weirs should be designed to remove the overflow liquid with low head.[5] Since the depth of the liquid has an effect on the plate efficiency, weirs should be designed to maintain as nearly as possible a constant level on the bubble plate. The longer the weir used, the less will be the variation in liquid depth due to the normal fluctuation occurring in column operation. Beall recommends an arbitrary value of $\frac{1}{8}$ in. as the maximum allowable variation in liquid depth.[10]

The head required above a weir to produce a certain rate of flow may be determined by application of the commonly used empirical weir formulas. Empirical data on flow over weirs have been obtained under steady conditions, while in a bubble column violent liquid agitation, splashing over the weir, and frothing of the liquid occur. However, a close approximation may be obtained by means of the Francis formula[5] for rectangular weirs, the Gourley formula[5] for circular weirs, and the general expression for sharp-edged V-notched weirs.[12]

## Effect of Down Spout Area

The effect of down spout cross-sectional area on column capacity has been given careful study by Kallam.[2] After an investigation of various shapes of down spouts, all of which had equal weir lengths or peripheries, a definite conclusion was reached to the effect that the area of the down spout is of greater importance than the perimeter in determining column capacity. This statement was modified by the suggestion that the down spout design and location must be such that the full area of the spout is available for unobstructed flow. The results obtained by Kallam indicate that a circular down spout and weir have the lowest capacity, while a down spout having a cross section in the form of a segment of a circle with a straight overflow weir has the greatest capacity. As the area included in the segmental section was considerably greater than that of the circle, and the weir length the same in both cases, the effect of down spout area on column capacity is readily seen.

This same study of down spouts also established the fact that there are certain minimum spout dimensions that must be observed in order to assure free flow of liquid over the weir. These, of course, will vary with the height of the liquid above the weir, but for most purposes the recommended minimum widths are 2 inches for down spouts in which the liquid overflows from all sides, and 1.75 inches for down spouts in which the liquid overflows from one side only. Another method of determining the width of a down spout is suggested in the arbitrary statement that the width should be approximately three times the height of the liquid over the weir.[9]

The liquid sealing of a down spout to prevent the short-circuiting of vapor through it is obtained by extending the lower end of the spout below the liquid level on the plate upon which it discharges. A U-bend in the lower end of the spout may also be used as a seal. Another means of sealing the spout is to provide seal

pots or pockets of the required depth on the plate below. When this is done the perimeter or upper edge of the seal pockets may be used as a distributing weir to aid in delivering the liquid uniformly over the plate.

## Pressure Drop

In columns operating under high pressures, any pressure drop over the column is generally of small importance. However, in columns operating at approximately atmospheric pressure or under vacuum, it is necessary to guard against extreme pressure drops through the bubble plates. The resistance to the flow of vapor through a plate is determined by the head of liquid above the bubble cap slots, the velocity of the vapor, friction loss through the vapor risers, bubble caps and slots and the loss due to the sudden contraction of area at the vapor risers.[1, 5, 9]

The liquid head above the cap slots is the distance from the operating liquid level to the center of pressure of the submerged bubble cap slot opening and may readily be established from the plate design. For the balance of the resistance to vapor flow, Robinson[1] explains that the friction of vapor through orifices at velocities of less than 100 ft. per second is small; thence for vapor flow at velocities of but 10 to 20 ft. per second this loss may be considered negligible. This leaves a velocity head only, which may be obtained by the expression: $h=c\,v^2/2g$, where $h$ is friction loss in head of vapor, ft.; $v$ is velocity of vapor, ft. per sec.; $g$ is acceleration due to gravity, or 32.2 ft. per sec.$^2$; and $c$ is a factor having a value of from 2.0 to 2.8.

The head required to produce flow through the vapor passages of a bubble plate, which includes the vapor risers, bubble caps and bubble cap slots, may also be approximated by the following expression:[5, 6, 9] $h=u^2/2g\,c^2$, where $h$ is head loss in feet of vapor; $u$ is velocity in feet per second; $g$ is gravity in ft. per sec.$^2$; and $c$ is a coefficient having a value ranging between 0.30 and 0.60. The coefficients $c$ in the above expressions must be determined experimentally for a particular plate design and operating condition.

The total loss in head occurring for vapor flow through a bubble plate may now be expressed as the sum of the head of liquid on the plate and the velocity head $h$ due to vapor flow through the plate.

The distance between bubble plates and the vapor velocity in a bubble column are the two most important considerations in securing high fractionating efficiency with minimum entrainment of liquid. The distance required between plates is given as being dependent upon the depth of liquid on the plates and the pressure drop or resistance to vapor flow set up by the bubble plate, also the velocity of the vapor and the design of the bubble caps and bubble plate.[1]

Robinson gives 6 in. as the minimum distance for the free space above the surface of the liquid to the plate above. This minimum figure should be used for ordinary vapor velocities only. A minimum spacing of 1 ft. has been recommended for general use if entrainment is to be prevented.[5] Walker, Lewis and McAdams[9] also suggest a distance of at least 6 in. between plates to allow for spattering and splashing. At any plate in a column, the pressure below the plate is greater than the pressure above it. This difference in pressure backs up the liquid into the down spout, so in any event the space between plates must be great enough to take care of this liquid head. A high pressure drop through a bubble plate may require an increase in plate spacing.

In practice, plate spacings in commercial columns are found to range from 6 to 36 in. For fractionating columns handling alcohol, whiskey, acetone and similar solvents, plate spaces of 6 to 9 in. give satisfactory results. In petroleum work it is customary to use spacings which in general range from 24 to 30 in.

In the final analysis, any determination of proper plate spacing requires (1) allowance for the depth of liquid on the plates, (2) sufficient free space above the liquid to allow vapor disengagement with entrainment, and (3) a sufficient distance to accommodate the pressure drop from plate to plate and maintain a liquid seal in the down spouts.

## Conservation of Heat

The loss of heat from a bubble column should be avoided as much as possible. A column operates with greatest efficiency when the amount of reflux is constant and at a maximum throughout the entire length of the column. Insulating a column against heat loss prevents intermediate condensation and also requires that the total reflux for the column be supplied at the top.

Various forms of insulation are used with success on bubble plate columns. The more common forms of magnesia block insulation, mineral wool blanket insulation and plastic insulation are all used, depending upon the distillation temperature.

The materials used in the construction of bubble plate columns are varied, and in the limited space available here it will be possible only to mention a few of those that are most common. For alcohol, acetone and acetic acid solutions, copper columns with copper bubble caps and plates are generally used. In petroleum work, most column shells are of steel plate, but the bubble caps and plates are made of either cast iron or steel. To combat corrosion in petroleum columns various types of linings are often used ranging from special alloy sheets to especially prepared cements or concretes. Complete bubble columns of special alloys are frequently made to meet certain corrosive conditions.

The material contained in this article is by no means intended to cover the entire field of column design. It has been presented, however, in the belief that the operation of many present day columns can be improved by the application of information already at hand.

### References


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Chemical Engineer's BOOKSHELF

# World Chemical Engineering

TRANSACTIONS OF THE CHEMICAL ENGINEERING CONGRESS OF THE WORLD POWER CONFERENCE. Edited by G. H. Ford. Published by Percy Lund, Humphries & Co., Ltd., 12 Bedford Square, London W.C.1. Five volumes. Price £12 per set, carrying charge extra.

THE FIRST International Chemical Engineering Congress has been widely hailed as an important milestone in our professional progress. It brought together for the first time in general conference the modern chemical engineering thinking from all parts of the world. Hence it is both appropriate and fortunate that its contributions have now been made permanent in the five volumes of the Transactions, reviews of which follow on this page.

In the Transactions the Congress papers retain their original order and group classification, and each group is followed by an account of the pertaining discussion from the floor. Of the 121 papers included, 102 are in English text, 15 are in German, and 4 are in French. The volumes are well-bound in buckram and are lettered in gold.

VOLUME I. Foreword; meetings reports; attendance lists; ferrous metals in chemical plant construction; refractories, rubber and other materials in chemical plant construction. 525 pages.

Reviewed by *James A. Lee*

THIS VOLUME gives a picture of recent world developments in materials for the construction of chemical equipment. The past few years have shown greater progress in the improvement of existing materials and the introduction of new products than any other period in history. And although there is an active world wide interest in these materials they may be in use in the country in which they originate for several years before their existence becomes known in other countries. The chemical engineer in the United States can well afford to read what his colleagues elsewhere are using to resist corrosion, heat and abrasion.

Practically the entire field of materials of construction is discussed. Ferrous and non-ferrous metals, refractories, rubber, plastics and a long list of other commercial materials come in for their share of treatment. In addition several papers cover related subjects: (1) forgings for the handling of fluids at high temperatures and pressures; (2) apparatus for the study of heat-insulating materials for use at low and high temperatures; (3) chemical engineering problems in relation to the coarser textile fibers—jute, cosi and sisal; and (4) experiments in the testing of and the effect of reducing gases on grog bricks for dart furnaces.

VOLUME II. Separation; size reduction, grading and mixing; electrolysis and electrical applications. 664 pages.

Reviewed by *T. R. Olive*

BY FAR the greater part of the material in this volume is concerned with separation, but even in so seemingly narrow a grouping not all the papers deal strictly with this unit operation. More than half are discussions of industrial processes wherein separation plays a leading part. Recovery of benzol in city gas manufacture, separation of CO and sulphur compounds from gas, constitute one group, while papers on petroleum refining constitute another dealing with fractionation of heavy oils, cracking and solvent extraction. A miscellaneous group deals with the production of absolute alcohol, road tar and hydrogen from methane.

Among the several papers treating separation as such are those on rectification and distillation, distillation calculations and crystallization, air and spray drying and evaporator design.

The remainder of the volume is less homogeneous in its classification. Three papers comprising the industrial group deal with power and its electrochemical uses. Four more attack the diverse subjects of electrical feed water treatment, electrical pasteurization, anodic oxidation of aluminum, and electrolytic removal of iron from aluminum solutions. One paper discusses new German methods for utilizing low-grade fuels, while still another, which better had been grouped with the construction materials papers, goes into the metallurgy of arc-deposited low carbon steel weld metal.

VOLUME III. Destructive distillation; treatment and disposal of effluents and waste materials; lubrication; high-pressure reactions and high vacua; heat exchange. 797 pages.

Reviewed by *R. L. Taylor*

DEVELOPMENTS in the gas industry are discussed in the first thirteen papers in this volume. A worthy American contribution is the paper by Fieldner and Davis which describes fully the A.G.A. methods for testing the carbonization properties of coals. Gas manufacturing practice in several foreign countries is discussed, and in Japan and Germany the interest appears to be in the low-temperature carbonization industry. The possibilities of producing cheap gas by underground gasification of virgin coals are discussed in a Russian paper.

The social, legal and technical aspects of problems of waste disposal in the United States and Great Britain are discussed in a second section of this volume. Then follow papers on the phenol process and liquid propane dewaxing process for the refining of lubricating oils. The possibilities of further development of solvent extraction refining and fractional precipitation are discussed.

High pressure reactions are becoming of increasing importance in organic synthesis. A section appearing under this heading considers the questions of special plant and equipment design and discusses hydrogenation and methanol synthesis from both the theoretical and operating points of view. High vacuum technology is presented principally from the standpoint of the various mechanical and physical means for securing the desired vacuum conditions. The much studied subject of heat economy in evaporation processes has been brought to the fore again in the section on heat exchange. This section also includes several good survey papers on heat transmission.

VOLUME IV. Education and training; statistics; administration; safety and welfare; trend of development; general aspects. 751 pages. VOLUME V. Index. 163 pages.

Reviewed by *S. D. Kirkpatrick*

AS THE London conference proceeded from the specific problems of industry and its technology to the more general aspects of chemical engineering, it is appropriate that Volume IV should be concerned with the broader interests of the profession—with managerial rather than purely technical problems. Basic to all of this is chemical engineer-

ing education which is presented in seven intensely interesting papers. Five of these contrast general principles and practices in Austria, Germany, England, Japan and the United States, while two are concerned with specific educational programs in the gas and petroleum industries. Able discussion by such men as Garland and Drane of England, Gillett of Belgium, Mueller of Belgium, Eucken of Germany, Goodwin of Canada and Brown, Dodge and Morgan of the United States adds greatly to the value of this section.

Safety and welfare of employees is assuredly a matter of deep concern to chemical engineers as evidenced by fine papers from Germany and England. Economic analysis of cost in process control (W. P. Fiske), of the influence of plant location (J. L. Warner) and the philosophy of formulating chemical engineering projects (Crosby Field) are worthwhile American contributions to chemical engineering economics.

One of the most difficult of all sections to handle was that on "Trends of Development" which was ably summarized by the general reporter, Prof. H. W. Cremer. These thirteen papers have little or nothing in common yet are certain to prove valuable reference sources for specific information on industrial trends. An equal number of papers fall into the concluding section on "General Aspects." Of broadest interest here are the discussions of the organization of research—with vivid contrasts of English, American, Russian and Japanese philosophy and practice.

The reference value of this set of books is greatly enhanced by the good job of indexing which occupies the entire 163 pages of the last volume. It includes a very complete listing of both subjects and authors.

This reviewer, who had the rare privilege of attending these sessions and listening to the original presentation of most of these papers, reaches this conclusion: Here in four volumes (and an index) is an almost complete and up-to-date library of chemical engineering. Anyone who studies and thoroughly comprehends all that is presented in the thousands of pages would have a very liberal education for our profession. And any chemical engineer who will take the time to familiarize himself with the contents of these books will be amply repaid for his effort because he is certain to find them extremely useful sources of both information and inspiration.

## GERMAN HANDBOOK

KURZGEFASSTES HANDBUCH ALLER LEGEIRUNGEN. By *Ernst Jaenecke*. Verlag Otto Spamer, Leipzig, Germany. 493 pages. Price 55 RM (bound).

Reviewed by *A. P. Hartlapp*

THIS condensed handbook presents the first systematic grouping of all alloys, whether of two metals or more. The author has successfully grouped the binary, ternary, and the more complicated quaternary alloys. Characteristics, physical and chemical properties, formation, and uses of each group are adequately presented. The text is amplified by calculations, curves, and manifold essential data.

The present volume is valuable not only for the thoroughness of its treatment, but also for the completeness of the bibliography listed with each alloy group.

## THERMODYNAMICS

ENGINEERING THERMODYNAMICS. By *Newton C. Ebaugh*. Published by D. Van Nostrand Co., Inc., New York City. 208 pages. Price, $2.85.

Reviewed by *M. E. Clark*

DESIGNED PRIMARILY as a college textbook, this work contains a very thorough yet concise treatment of the elements of thermodynamics as applied to engineering. In the first eight chapters encompassing only 106 pages the author sets forth the fundamental conceptions involved in mechanical, internal, and heat energy with a minimum of elaboration and unimportant detail. Included are definitions of terms, statements of laws, derivations of the process formulas for perfect gases and their application to theoretical and actual cycles, discussions of the properties of vapors and gas mixtures, and a brief treatment of air conditioning.

The last five chapters show the application of the principles of thermodynamics to flow of fluids, vapor power prime movers, internal combustion engines, gas compression, and refrigeration cycles.

A generous supply of graphs, diagrams, equations and tables serves to break the monotony of solid type, and bold face and italics are used quite effectively to accentuate the more important statements. A number of problems are provided at the end of every chapter and the answers are given in the appendix. The appendix also contains condensed steam tables of Keenan and Keyes, as well as a psychrometric chart for air conditioning and a Mollier chart for ammonia. In a pocket on the inside of the back cover is a large Mollier chart (24x36 in.) on which are plotted steam pressures up to 5,500 lb. per sq.in. absolute and steam temperatures up to 1,200 deg. F.

Because this book offers a surprising wealth of material in a small space and because it contains so many excellent charts and graphs, it is recommended as a valuable addition to any engineer's reference shelf.

## CHEMISTRY'S TRUE ROLE

MAN IN A CHEMICAL WORLD. By *A. Cressy Morrison*. Published by Charles Scribner's Sons, New York City. 292 pages. Price, $3.

Reviewed by *R. L. Taylor*

CHEMICAL INDUSTRY has for the past 20 years been popularly presented to the American people in one of two lights. Either it has been eloquently described as a wonder industry capable of working all manner of magical changes upon the things we grow or dig out of the ground, or it has been decried as a destroyer of life and property, a ravager of streams and countrysides.

In this book which was written in connection with the American Chemical Industries Tercentenary, Mr. Morrison has succeeded in presenting what most men closely connected with the industry will consider a remarkably true picture of its rôle in modern, everyday American living. He has made a laudable effort to get away from the usual recounting of synthetic miracles. The reader will find offered in simple and straightforward style a highly informative story of how chemistry contributes to the modern American forms of such of life's necessities as food, clothing, shelter, medicine, transportation, communication, social security, and as well those little luxuries that make up the "more abundant life." Practically the entire book treats of the present. There is little historical matter included, and all crystal gazing is confined to a single chapter at the end.

In the opinion of this reviewer, the thing which distinguishes the book is its wealth of good, practical information, with the propaganda reduced to a minimum. For this reason, and because it is a sample of decidedly better-than-average narrative, chemical engineers as well as their non-technical friends will find it worthwhile extra-curricular reading.

## THIRTY-SEVEN BILLIONS

THE NATIONAL DEBT AND GOVERNMENT CREDIT. Factual findings by Paul W. Stewart and Rufus S. Tucker, assisted by Carolyn Stetson. Published by Twentieth Century Fund, Inc., New York City. 171 pages. Price, $1.75.

Reviewed by *S. D. Kirkpatrick*

HAS THE unprecedented government debt already undermined government credit? Will further increases in debt seriously threaten the confidence of American investors? These are questions that this book answers, factually and authoritatively. And on such facts, the non-partisan Committee on Government Credit of the Twentieth Century Fund has laid out a definite program of action based on the urgent necessity for

reduction of this unprecedented debt.

Self interest of every American citizen urges the reading of this book in order to learn more of the problems we must face as a nation during the next decade. With the debt of the Federal Government almost $37,000,000,000—the highest in our history, in fact exceeding that of any other nation in the world—we may well concern ourselves with what is going to happen if it continues to mount much higher. This book is a calm, dispassionate discussion, supplemented by a remarkable set of charts which convey their story quickly and convincingly. Chemists and engineers familiar with the work of Dr. Stewart while with the Department of Commerce and later in process industries, will appreciate the thoroughness and authority with which this fact-finding study has been completed.

## GOVERNMENT PUBLICATIONS

***Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.***

*Recent Advances in the Vacuum Fumigation of Cereal Products With Certain Fumigants,* by R. T. Cotton and others. Bureau of Entomology and Plant Quarantine, E-405; mimeographed.

*Recommendations for the Control of Insects Attacking Certain Vegetables, Small Fruits, and Tobacco,* by W. H. White. Bureau of Entomology and Plant Quarantine, E-376 (Revised): mimeographed.

*Soy Bean Culture and Varieties,* by W. J. Morse. Department of Agriculture Farmers' Bulletin 1520, 1937 Reprint; 5 cents.

*The Comparative Moisture-Absorbing and Moisture-Retaining Capacities of Peat and Soil Mixtures,* by I. C. Feustel and H. G. Byers. Department of Agriculture Technical Bulletin 532; 5 cents.

*The Commercial Classification of American Cotton,* by Arthur W. Palmer. Department of Agriculture, Department Circular 278; 10 cents. Refers to standards for grade, color, and staple.

*Forest Trees and Forest Regions of the United States,* by Wilbur R. Mattoon. Department of Agriculture Miscellaneous Publication 217; 15 cents.

*Comparison of Various Chemical Quick Tests on Different Soils,* by M. S. Anderson and W. M. Noble. Department of Agriculture Miscellaneous Publication 259; 5 cents.

*Census of Clay Products (Including Pottery) and Non-clay Refractories,* 1935 and 1936. Bureau of the Census; mimeographed.

*List of Publications of the Department of Commerce,* July 1, 1937, Edition. Department of Commerce unnumbered document.

*Trading Under the Laws of Venezuela,* by Henry P. Crawford. Bureau of Foreign and Domestic Commerce, Trade Promotion Series 170; 15 cents.

*Sand-Lime Brick.* Bureau of Standards Simplified Practice Recommendation R38-37; 5 cents.

*Sources of Current Trade Statistics.* Bureau of Foreign and Domestic Commerce. Market Research Series No. 13; 25 cents.

*Animal and Vegetable Fats and Oils.* Bureau of the Census unnumbered document; 5 cents. Production, consumption, imports, exports and stocks, quarterly for calendar years 1932 to 1936; 5 cents.

*Fats, Oils, and Oleaginous Raw Materials—Production, Prices, Trade, Disappearance in the United States 1912–35 and Available Data for Earlier Years,* by Anne Dewees. Department of Agriculture Statistical Bulletin 59; 10 cents.

*Federal Specifications.* New or revised specifications of the Federal Specifications Board on: Soap and soap-products, general specifications (methods for sampling and testings, P-S-536; Paint, outside, ready-mixed, medium chrome yellow, TT-P-53; Paints, Oil, interior, eggshell-flat-finish, ready-mixed and semi-paste, light-tints and white, TT-P-51a; Volumetric apparatus, glass, DD-V-581; 5 cents each.

*Evaluation of the Industrial Hygiene Problems of a State,* by J. J. Bloomfield and Mary F. Peyton. Public Health Service Bulletin 236; 15 cents.

*American Delegations to International Conferences, Congresses and Expositions and American Representation on International Institutions and Commissions With Relevant Data, Fiscal Year Ended June 30, 1936.* Department of State, Conference Series No. 30, Publication 1014; 20 cents.

*International Traffic in Arms.* Department of State Publication No. 1023, Fourth Edition; 10 cents. Laws and regulations administered by the Secretary of State governing the international traffic in arms, ammunition, and implements of war and other munitions of war.

*Technologic Trends and National Policy, Including the Social Implications of New Inventions.* Report of the Subcommittee on Technology to the National Resources Committee; $1.00.

*Wool Prices.* Tariff Commission Report No. 120, Second Series; 10 cents. Includes a comprehensive glossary of wool terms.

*Computed Duties and Equivalent ad Valorem Rates on Imports Into the United States from Principal Countries, Calendar Years 1929, 1931, and 1935.* Tariff Commission, W.P.A. Statistical Project 265-31-7000; mimeographed.

*Sodium Sulphate.* Tariff Commission, advance preliminary edition, mimeographed. A survey of the U. S. production, consumption, and foreign trade with particular reference to factors essential to tariff consideration.

*Geologic Factors in the Interpretation of Fluorspar Reserves in the Illinois Kentucky Field,* by L. W. Currier. U. S. Geological Survey Bulletin 886-B; 5 cents.

*Temperature of Water Available for Industrial Use in the United States,* by W. D. Collins. U. S. Geological Survey Bulletin 520-F, 1937 reprint; 10 cents.

*The Composition of the River and Lake Waters of the United States,* by F. W. Clarke. U. S. Geological Survey Professional Paper 135, 1937 reprint; 50 cents.

*The Industrial Utility of Public Water Supplies in the United States, 1932.* U. S. Geological Survey Water-Supply Paper 658, 1937 reprint; 15 cents.

*Methods of Locating Salt-Water Leaks in Water Wells,* by Penn Livingston and Walter Lynch. U. S. Geological Survey Water-Supply Paper 796-A; 10 cents.

*Effect of the Size of the Manhole on Natural Ventilation,* by G. W. Jones and others. Bureau of Mines Report of Investigations 3343; mimeographed. Part 2 of a series on ventilation of manholes.

*Low-Temperature Distillation Tests of Subbituminous Coal From the Denver Region Coal Field, Colorado,* by W. H. Ode and W. A. Selvig. Bureau of Mines Report of Investigations 3342; mimeographed.

*Cooperative Fuel Research Motor-Gasoline Survey, Winter 1936–37,* by E. C. Lane. Bureau of Mines Report of Investigation 3348; mimeographed.

*Bureau of Mines Apparatus for Demonstrating Electrical Ignition of Mine Gas,* by E. J. Gleim. Bureau of Mines Information Circular 6944; mimeographed.

*Mining and Milling Methods at the Pilgrim Mine, Chloride, Ariz.,* by Earl F. Hastings. Bureau of Mines Information Circular 6945; mimeographed.

*A Preliminary Report of the Survey of Crude Oil in Storage 1936–37.* Bureau of Mines, Supplement to Monthly Petroleum Statement 159; mimeographed.

*Mineral Production Statistics for 1936.* Preliminary mimeographed statements on the various minerals, most of which are now available from the Bureau of Mines. These will be included in the 1937 Minerals Yearbook to be issued shortly.

*Control of Chromic Acid Mists From Plating Tanks,* by Edward C. Riley and F. H. Goldman. Public Health Service Reprint No. 1801; 5 cents.

*Some Aspects of Blanket Coverage of Occupational Diseases in the United States.* Public Health Service Reprint No. 1809; 5 cents.

*A Study of Chronic Mercurialism in the Hatters' Fur-Cutting Industry,* by Paul A. Neal and others. Public Health Service Bulletin No. 234; 15 cents.

*Program for Prevention and Compensation of Silicosis.* Bureau of Labor Statistics Serial R. 545.

*Ground-Water Supplies.* Public Health Service, Supplement No. 124 to the Public Health Reports; 5 cents. Progress report of the committee on ground-water supplies conference of state sanitary engineers, 1936.

*Quantity of Wood Treated and Preservatives Used in the United States in 1936,* by R. K. Helphenstine, Jr. Forest Service unnumbered pamphlet.

*Production and Agricultural Use of Sodium Nitrate,* by Albert R. Merz and C. C. Fletcher. Department of Agriculture Circular 436; 5 cents.

*Agricultural Statistics, 1937.* Department of Agriculture unnumbered book; 50 cents. Statistical supplement to the Yearbook of Agriculture.

*First Annual Report on Tobacco Statistics (With Basic Data).* Department of Agriculture Statistical Bulletin 58; 15 cents.

*A History of Agricultural Experimentation and Research in the United States, 1607–1925,* by Alfred Charles True. Department of Agriculture Miscellaneous Publication 251; 25 cents.

*The Rubber Industries, Census of Manufactures, 1935.* Bureau of the Census unnumbered pamphlet; 5 cents.

*A Guide to the Literature on Rubber.* Bureau of Standards Letter Circular 501; mimeographed.

*Recovery of Potash From Tailing of a Porphyry Copper Property,* by G. L. Oldright and others. Bureau of Mines Report of Investigations 3349; mimeographed.

*The National Bureau of Standards and the Establishment of Hard Refined Dextrose and Levulose Industries,* by Frederick Bates. Bureau of Standards Letter Circular 500; mimeographed.

*Consumption of Pulpwood and Production of Wood Pulp.* **Census of Forest Products,** 1936, Bureau of the Census; mimeographed.

*A Digest of Trade Hints for Paint and Varnish Merchants.* Monthly publication of the Bureau of Foreign and Domestic Commerce in cooperation with National Paint, Varnish and Lacquer Association; subscription 50 cents per year.

*The Exchange Situation in Latin America.* Bureau of Foreign and Domestic Commerce, Finance Division Special Circular 423; mimeographed.

*World Economic Review, 1936—Part I. United States.* Bureau of Foreign and Domestic Commerce unnumbered document; 15 cents.

*Leather Footwear; World Production and International Trade,* by J. G. Schnitzer. Bureau of Foreign and Domestic Commerce Trade Promotion Series 168; 20 cents.

# Readers' VIEWS and COMMENTS

## Science and Politics

*To the Editor of Chem. & Met.:*

Sir:—In your August editorial entitled "Science vs. Politics" you mention Technocracy as of "short-lived popularity," and you also state, " . . . they hold forth empty promises, just as dangerous and as futile as the false premises of Technocracy."

It is very interesting to have *Chem. & Met.* admit after five years that the human beings on the North American continent are intensely interested in the relation of science to the conduct of human affairs.

Technocracy, Inc., concurs in the doubts expressed in your editorial, that there is no probability that any political government on this continent has the intelligence, vision, forthrightness, or structural facility to accomplish the direction and control of the technological application of physical science to the means whereby we live on the North American continent.

If you would investigate, you would find that the people of North America, especially in the United States and Canada, have in a considerable number examined the relation of science and politics much beyond the limitations set down in your editorial.

HOWARD SCOTT
Director-in-Chief, Technocracy, Inc.
New York City

*To the Editor of Chem. & Met.:*

Sir:—Your August issue seems to have gone into political economy in the belief that it is more important to the world than chemical engineering. Your editorial "Science and Politics" cites the fact that five years ago Technocracy "found itself in the limelight" but you assume that it "held forth futile promises." Technology did not have "false premises" or any other premises, except that as a fact-finding enterprise it demonstrated fully that modern machinery and methods eliminated the necessity for so many to be employed so long to produce our needed goods and products. It did not have the answer and that is the reason for its decline in public interest.

"Technological Trends and National Policy," reported by the National Resources Council realized the influence of invention on the elimination of the need for labor, but neither did it have the answer.

Your "editorial viewpoint" inclines politically in its reference to the article on page 418 by Prof. Theodore J. Kreps of Leland Stanford who was a delegate to the International Labor Conference at Geneva and advises a forty-hour week for the chemical industry. This is proper, but why limit it to this one industry? Would not such an act give an even greater tendency for many to seek this as a superior and more pleasant industry to work in with the result that the pressure for jobs would be even greater.

The present writer has long realized that the answer to the new labor situation is to have universal, compulsory limitation of the working time for wages.

As far back as the Hoover administration, this writer printed an article showing that two years before that, the Geneva Labor Conference closed with the statement that "owing to the nonconcurring of a great American nation, an international labor treaty could not be realized."

Unless other highly mechanized nations join in an international treaty we cannot compete in the world markets. Without equality of prices we cannot export. As "This constitution and treaties made thereunder are the supreme law of the land" and the courts are specifically forbidden by the constitution to question treaties regularly made, it is evident that this is the only legal method of providing that "No person shall work for wages more than forty hours per week." This is the only practical method of solving the labor problem of the whole world. We must share the work.

Why limit the forty-hour week to the chemical industry? Only a universal, uniform week will solve the problem of "overproduction," which means a production in excess of capacity to purchase and use all the surplus. We have tried all manner of unconstitutional "meddling" and paternalism but we have steadily refused to do the obvious thing and put the whole world on the same basis of a short week of forty hours working time. We refuse to relieve the surplus of labor that has disrupted our economy and threatens revolution if continued as now by rioting of the physically powerful against the intellectually better portion of the public.

H. O. CHUTE
Chemical Engineer
New York City

### CHEMICAL-CLINICAL CONTROVERSY

*To the Editor of Chem. & Met.:*

Sir:—In your August, 1937, issue, page 443, appears a letter signed by Milton A. Lesser, calling attention to some writings on the subject of cigarette smoke and its effects on the throat, which, it is claimed refute much that has previously been published concerning cigarettes made with diethylene glycol.

The author of the letter sent to you is a chemist whose qualifications for judging clinical evidence are not apparent. The bibliography of Mr. Lesser, so far as it concerns glycerine, indicates that he has devoted himself largely to encouraging the use of that substance not only in cigarettes but in practically every other phase of human life. Certainly one would not be inclined to accept him as an unbiased critic in this field. Inasmuch as he has cited in his article the exceedingly brief bibliography which favors the use of glycerine and opposes the use of diethylene glycol, it would have been much more fair to cite at the same time the bibliography of the articles prepared from a different point of view and based on far more extensive clinical evidence than is cited in Mr. Lesser's letter.

The concluding paragraphs of his letter contain an insinuation which cannot be supported by any evidence.

MORRIS FISHBEIN, M. D.
Editor, *Journal of the American Medical Association*
Chicago, Ill.

# Your Plant NOTEBOOK

## Designing a Safety Backstop

By C. A. LEE
Darling & Co., Chicago, Ill.

BOTH belt conveyors on an incline and bucket elevators have an undesirable tendency to run backwards when stopped under load. A number of different arrangements have been employed to prevent this and in most cases their cost is justified.

These safeguards range all the way from a simple ratchet on the head shaft to a solenoid brake on the motor. It is the present writer's belief that the latter device is somewhat to be preferred in spite of the fact that it could not act in case the gear teeth should be stripped somewhere in the train. The preference arises from the fact that power failures are so much more common than accidents to the gearing.

One arrangement that is often used is to install a cast steel ratchet wheel on the head shaft, with a frictional device for holding the pawl out of mesh during forward drive. Ratchets are necessarily somewhat coarse pitched and are usually made a good deal smaller than the head wheel itself. As a result, angular motion for one full tooth permits the development of a rather high momentum which, when absorbed in the fraction of a second corresponding to sudden engagement, develops extremely high stresses. The writer has known of this type tearing loose and doing serious damage. Hence it appears not to be safe on important jobs, while for unimportant ones, the expense is unjustified.

Of the approved arrangements, one of the simplest consists of a pawl meshing with the drive gear itself. The pawl is held slightly out of mesh in normal operation, but drops into engagement the moment reversal sets in. It is thus impossible for momentum to build up. Simple as it is, however, there are several points in its design that have not been thoroughly understood; otherwise, its use would be more widespread.

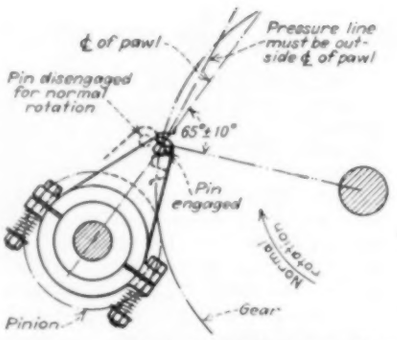



**Diagram of silent pawl backstop applied to conveyor drive gear**

This mechanism, sometimes termed the "silent pawl," is shown in the accompanying sketch. It consists of a cross bar mounted between two arms spanning the drive pinion. Usually the arms ride on extended hubs of the pinion. Frictional contact holds the pawl against a stop so that the cross bar just clears. The same frictional contact causes reverse motion immediately to engage the pawl. Contact is maintained by springs and the wear is reduced to a minimum by grease lubrication.

The cross bar of the pawl is usually a round pin which can be made of nickel steel. Its size is important in securing proper results, the best diameter being that which meshes a little outside the pitch circle of the gear. Such a pin is in proportion; at the same time, it avoids the possibility of wedging.

The radius of the pawl arms is generally selected to agree with patterns that are available, but it has certain limits for successful operation. Too short a radius gives a flat angle and has been known to force the pinion out of mesh. On the other hand, too long a radius gives such a steep angle that the pin may slip out of engagement, as will be clear from the drawing.

There is one more feature of importance. Sometimes the direction of drive is such that the pin must lift to engage. In that case the arms must be counterbalanced to insure engagement without requiring too much tension in the springs. Otherwise the frictional requirement will be so great that wear will be excessive.

## Capacity Per Inch of Depth of Vertical Cylindrical Tanks

By JAMES T. KENNEY
Antioch, Calif.

BELOW is a tank capacity chart which I worked out for my own use, but which has proven so convenient that it may be worth while for others in the process field. The chart gives gallons per *inch* of depth for vertical cylindrical tanks from 2 to 30 ft. in diameter, by steps of 1 in. diameter to 14 ft., 3 in. diameter to 20 ft., and 6 in. diameter to 30 ft. It is an extension and modification of a type of chart frequently found in handbooks in which the gallonage is computed per *foot* rather than per inch of depth. Its use is self-explanatory. For example, the intersection of the row for 10 ft. and the column for 6 in. gives 53.98 gal. per inch, the capacity per inch of a 10 ft. 6 in. I. D. tank.

**Gallons Per Inch of Depth in Vertical Cylindrical Tanks**

| Diameter Feet | Inches 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 2 | 1.958 | 2.175 | 2.298 | 2.479 | 2.666 | 2.859 | 3.073 | 3.267 | 3.482 | 3.703 | 3.931 | 4.080 |
| 3 | 4.406 | 4.655 | 4.910 | 5.171 | 5.440 | 5.715 | 5.998 | 6.287 | 6.582 | 6.885 | 7.195 | 7.511 |
| 4 | 7.85 | 8.16 | 8.50 | 8.84 | 9.19 | 9.55 | 9.91 | 10.28 | 10.66 | 11.05 | 11.44 | 11.84 |
| 5 | 12.24 | 12.65 | 13.07 | 13.50 | 13.93 | 14.36 | 14.81 | 15.26 | 15.72 | 16.19 | 16.66 | 17.14 |
| 6 | 17.63 | 18.12 | 18.62 | 19.12 | 19.64 | 20.16 | 20.69 | 21.22 | 21.76 | 22.31 | 22.86 | 23.42 |
| 7 | 23.99 | 24.56 | 25.15 | 25.74 | 26.33 | 26.93 | 27.54 | 26.33 | 28.78 | 29.54 | 30.04 | 30.68 |
| 8 | 31.33 | 31.99 | 32.65 | 33.32 | 34.00 | 34.68 | 35.37 | 36.07 | 36.77 | 37.48 | 38.20 | 38.93 |
| 9 | 39.66 | 40.40 | 41.14 | 41.91 | 42.65 | 43.45 | 44.19 | 44.97 | 45.75 | 46.54 | 47.34 | 48.15 |
| 10 | 48.96 | 49.78 | 50.61 | 51.44 | 52.27 | 53.13 | 53.98 | 54.84 | 55.71 | 56.58 | 57.46 | 58.35 |
| 11 | 59.24 | 60.14 | 61.05 | 61.96 | 62.89 | 63.81 | 64.75 | 65.69 | 66.64 | 67.60 | 68.56 | 69.53 |
| 12 | 70.34 | 71.48 | 72.47 | 73.47 | 74.47 | 75.48 | 76.48 | 77.52 | 78.55 | 79.59 | 80.63 | 81.69 |
| 13 | 82.74 | 83.82 | 84.88 | 85.96 | 87.04 | 88.13 | 89.23 | 90.33 | 91.45 | 92.56 | 93.69 | 94.82 |
| 14 | 95.96 | 97.11 | 98.26 | 99.42 | 100.60 | 100.76 | 102.94 | 104.12 | 105.32 | 106.52 | 107.72 | 108.93 |
| 15 | 110.16 | ..... | ..... | 113.86 | ..... | ..... | 118.63 | ..... | ..... | 124.28 | ..... | ..... |
| 16 | 125.34 | ..... | ..... | 129.28 | ..... | ..... | 133.30 | ..... | ..... | 136.00 | ..... | ..... |
| 17 | 141.50 | ..... | ..... | 145.69 | ..... | ..... | 149.94 | ..... | ..... | 154.25 | ..... | ..... |
| 18 | 158.63 | ..... | ..... | 161.58 | ..... | ..... | 167.56 | ..... | ..... | 172.13 | ..... | ..... |
| 19 | 176.75 | ..... | ..... | 181.43 | ..... | ..... | 186.17 | ..... | ..... | 190.97 | ..... | ..... |
| 20 | 195.84 | ..... | ..... | 200.77 | ..... | ..... | 205.75 | ..... | ..... | 210.80 | ..... | ..... |

| Diameter Feet | Inches 0 | 6 |
|---|---|---|
| ..... | ..... | ..... |
| 21 | 215.91 | 226.32 |
| 22 | 236.32 | 247.86 |
| 23 | 259.00 | 270.38 |
| 24 | 282.01 | 293.88 |
| 25 | 306.00 | 318.37 |
| 26 | 330.97 | 336.00 |
| 27 | 356.92 | 370.26 |
| 28 | 383.85 | 397.68 |
| 29 | 411.75 | 426.17 |
| 30 | 440.64 | ..... |

# Process Equipment NEWS

# Machinery, Materials and Products

## Bag Weighing Machine

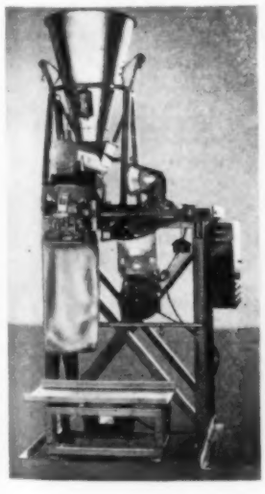
BAGS IN CAPACITIES up to 100 lb. can be filled accurately with a new bag weighing machine recently been put on the market by the Syntron Co., Homer City, Pa. Bulk material is fed from a storage bin or conveyor to the supply hopper on the machine. A noiseless vibrator on the hopper agitates the contents, preventing arching and clogging. A vibrating electric feeder then flows material from the hopper to the bag opening. The bag is held in a quick-acting, hand-operated chuck, mounted on a scale beam.

Initial flow of material is at high speed until the bag is nearly filled. Then, by electric control, the scale cuts down the flow to a dribble, finally cutting off at exact weight. Extreme precision is claimed for this new device.

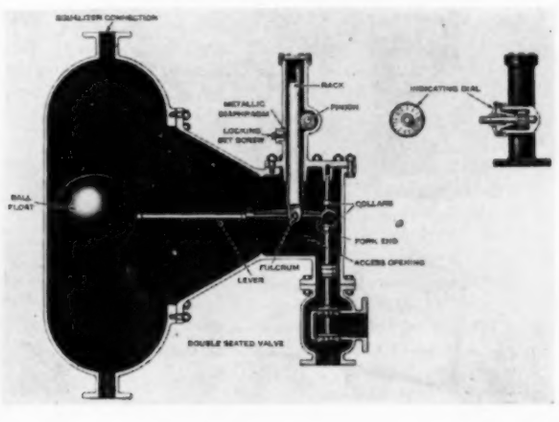
## Level Controller

EASY ADJUSTABILITY is an important feature of a new liquid level controller recently developed by the evaporator division of Struthers-Wells Co., Titusville, Pa. The features of the new controller are evident in the accompanying wash drawing which shows the adjustable float arm fulcrum, positioned by a rack. The height of the fulcrum is shown by an indicating dial. Motion of the float is transmitted by a fork to a pair of collars on the stem of a balanced valve. The new controller is said to be adaptable to existing equipment such as evaporators, reboilers and other equipment where liquid level tends to surge.

**Electric vibrating bag packer**



**Details of new liquid level controller**




## Heat Releasing Link

LOADS UP TO 150 lb. can be carried by the new Quartzoid link for heat-operated releasing devices manufactured by the Grinnell Co., Providence, R. I. This compares with the 20 lb. rating for ordinary solder type links which, when used, must be ganged when unusual weight is to be resisted. The new link uses the same quick-acting element employed in this company's Quartzoid sprinkler head. The bulb is said to be extremely sensitive yet immune to corrosion, completely shattering at its rated temperature.

## Effective Temperature Indicator

A NOVEL PRINCIPLE in thermometry has been applied in the Bailey-Parsons Therhumiter which has recently been developed and placed on the market by John R. Parsons, consulting physicist, 151 East 19th St., New York City. The new instrument combines an "effective temperature thermometer" and a dry bulb thermometer reading on the same scale. The effective temperature thermometer comprises a wet and a dry bulb thermometer in series, the two bulbs being separated by a capillary. The wet bulb is encased in a wick supplied with water from a reservoir. Hence, the height of the liquid column is determined by both the wet and dry bulb temperatures and the relative effect of each is so adjusted as to give a reading of effective temperature.

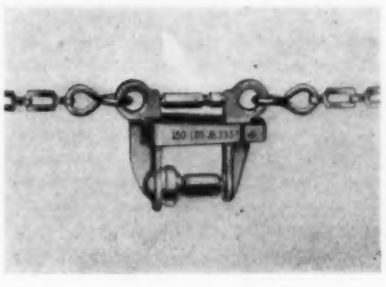
Effective temperature is a relatively new temperature scale used by air conditioning engineers as a measure of comfort under a given set of air conditions. Its components are temperature, humidity and air motion. Various combinations of these factors will give the same effective temperature, that is, the same feeling of comfort.

The purpose of supplying the additional dry bulb thermometer is to permit the direct reading of relative humidity and dry bulb temperature, without the use of tables. The dry bulb temperature is read directly while relative humidity may be calculated in a very simple manner from the difference between the heights of the effective temperature and dry bulb liquid columns.

## Acid-Resisting Alloy

THROUGH the cooperation of Haynes Stellite Co., Kokomo, Ind., and Union Carbide & Carbon Research Laboratories, Inc., a new alloy known as Hastelloy B is now available for use under extremely severe conditions of corrosion. This alloy is a further addition to the series of Hastelloy alloys originally developed eight years ago. It is produced primarily for service in equipment handling hydrochloric acid in all concentrations and at temperatures up to

**Quartzoid heat releasing link**



and including the boiling point. It is also stated to stand up well in sulphuric and phosphoric acids, acetic and other organic acids and in non-oxidizing acid chloride solutions. In 20 per cent HCl at the boiling point, the rate of penetration is reported as only 0.0016 in. per month.

The new alloy is similar to Hastelloy A in being composed of nickel, molybdenum and iron, except that the proportion of iron has been decreased and the molybdenum content increased. Hence the alloy has a higher ultimate tensile strength and higher yield point, with practically no loss in ductility. Its physical properties are said to be comparable to those of a good grade of alloy steel, making possible its fabrication by forging, rolling, welding and casting.

## Magnetic Separator

REDESIGN of its Type L magnetic separator has been accomplished by the Stearns Magnetic Mfg. Co., Milwaukee, Wis. Among the new features is a self-contained complete drive. The motor can be operated from any convenient a.-c. source, although the machine may also be equipped for d.-c. operation. The motor is sufficiently large for the driving of both the generator and the separator. Safety has been enhanced by concealing all operating parts, while lower operating cost has been achieved through the use of anti-friction bearings throughout. The new unit is being used successfully, according to the manufacturers, in the treatment of abrasives, carbon, fertilizers, glass cullet, casein and similar materials.

## Remote Recorders

WHAT IS SAID to be the first instrument capable of recording relative humidity directly, from a remote point, has been developed by Julien P. Friez & Sons, Baltimore, Md. This instrument is one of a new line of round-chart recorders for humidity and temperature announced by this company.

The humidity sensitive instrument is one of this company's standard multiple human-hair elements. The indication is transmitted to the recorder over a five-wire electrical system, using synchronous positioning motors in indicator and receiver. Remote temperature indication is obtained by the same means and may record on the same chart. For short distance transmission of temperature alone, however, the usual capillary tube method is employed.

Remote instruments are regularly available for recording at distances up to 5,000 ft. while greater distances can be handled to special order. Humidity recorders cover the entire range from 0 to 100 per cent relative humidity, while temperature instruments are available in various ranges from —34 to 200 deg. F.

## Plastic Filter

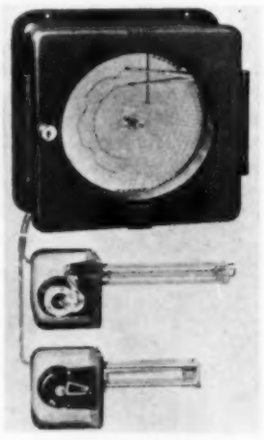
A RECENT DEVELOPMENT of the Haveg Corp., Newark, Del., is the production of a new suction filter molded in one piece from Haveg phenol-formaldehyde resinoid. As appears from the accompanying illustration, the holes and the drainage grooves have been arranged to facilitate drainage. The filter is resistant to almost all acids and to a wide variety of other chemicals, and can be used continuously at operating temperatures to 265 deg. F.

## High Temperature Exhaust Fan

GAS TEMPERATURES as high as 1,250 deg. F. (and even up to 1,800 deg. F. when employing a special unit) can be handled in an improved line of high temperature exhausters recently developed by the Industrial Gas Engineering Co., 201 East Ohio St., Chicago, Ill. These exhausters employ a patented, double-housing, insulated and air cooled construction for the higher temperatures, although a single housing of uninsulated construction is used in some applications. All parts subjected to high temperatures are fabricated of heat-resisting alloys. A patented air-cooling method is used to cool the double row self-aligning ball bearings. Ready access to the exhauster wheel is provided.

Three classes of Thermo Exhausters are made, Class L for operating temperatures to 800 deg. F., Class M for operating temperatures to 1,000 deg. F., and Class H for operating temperatures to 1,250 deg. F. Special units can be furnished for higher temperatures to 1,800 deg. F.

**Remote temperature-humidity recorder**



Process Equipment NEWS

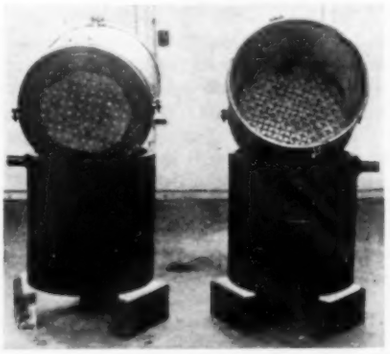
## Fireproof Cable

GENERAL ELECTRIC CO., Schenectady, N. Y., has developed a new synthetic insulating compound, recently introduced under the name of Flamenol, which is said to be mechanically strong, non-combustible, and resistant to aging, moisture, acids, alkalis and oils. This material is being employed for the insulation of cable used for power and control circuits at voltages of 600 and less. The new material, while similar to rubber in its characteristics, contains no rubber and will not support combustion. It can be made soft and flexible, or of a bone-like rigidity. It can be put into solution for coating or impregnating and can be compounded, calendered, and extruded much like rubber. Only where cable will be subjected to extreme mechanical abuse is it necessary to provide Flamenol-insulated cable with any protective finish.

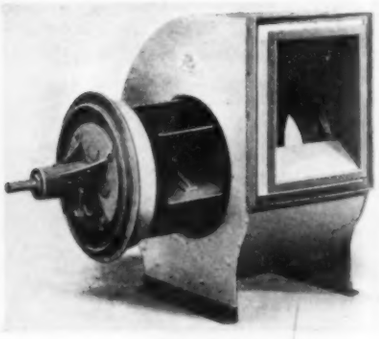
## Centrifugal Stock Pump

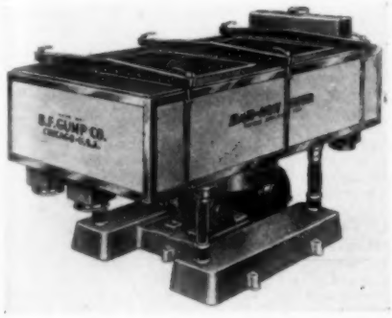
NEW PAPER STOCK pumps embodying advanced features have been announced by the Worthington Pump & Machinery Corp., Harrison, N. J. These pumps

**Two views of new Haveg suction filter**

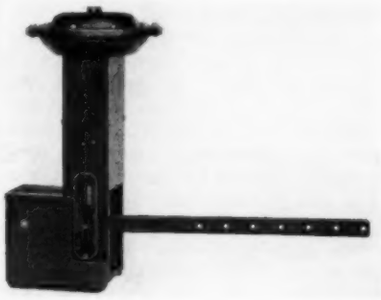


**High temperature exhauster with fan wheel exposed**






**Above: Section of porcelain tubing**
**Left: New rotary-motion sifter**
**Below: All-steel welded lever motor**



are stated to be capable of handling paper stock of all kinds and consistencies up to 6¼ per cent and higher, and are claimed to be highly efficient, non-overloading and easily inspected. The angle-split casing and bearing housing that are used form an integral part of the design and safeguard against misalignment. A heavy, oversized shaft mounted on ball bearings prevents deflection. The extra deep stuffing box is subjected to suction pressure only while the special design of non-clogging impeller is said to prevent air separation.

These pumps are made in six sizes, operating at low speeds against total dynamic heads of 10 to 160 ft., with capacities ranging from 100 to 3,500 g.p.m.

## Porcelain Pipe

PURE PORCELAIN, glazed inside and out, is used for a new line of acid-resisting pipe developed by the Lapp Insulator Co., LeRoy, N. Y. The porcelain is stated to be non-porous and non-absorbent, so that a scratch or crack will not permit liquid to be absorbed or contaminated. Of importance where good appearance of the installation is necessary is the fact that the tubes are glossy white, supplied with chromium plated fittings.

## Rotary-Motion Sifter

A NEW TYPE of rotary motion sifting unit, designed principally for sifting and rebolting of fine powders, has been announced by the B. F. Gump Co., 431 South Clinton St., Chicago, Ill. The entire sieve area is given a mechanically controlled, complete rotary motion which is said to produce exceptionally large capacity. Other advantages claimed for the new equipment include complete separation of tailings and finished product on the individual sieves, ready accessibility of the sieves, and sturdy, compact construction. The new sifter, which has been given the name of Bar-Nun, is available in three sizes, furnished either one, two or three sieves deep for sifting and rebolting, and from two to five sieves deep for separating or grading work.

## Diaphragm Lever Motor

FOR THE OPERATION of dampers, butterfly valves, rheostats and similar equipment, the Taylor Instrument Cos., Rochester, N. Y., have developed a new diaphragm lever motor of all-welded steel construction to which the name Motosteel Even Action lever motor has been given. It is claimed that the device possesses precision operation characteristics which assure a uniform relation between the air pressure applied to the diaphragm and the resulting lever travel throughout the stroke. It is said to be practically free from hysteresis owing to the use of a deep diaphragm and ball bearing guides for the push rod. The motor is made in three sizes which are expressed in terms of the maximum damper areas that can be accurately positioned, namely, 25, 50, and 120 sq.ft. rating.

## Equipment Briefs

AMERICAN SCHAEFFER & Budenberg Division of Consolidated Ashcroft Hancock Co., Bridgeport, Conn., has recently announced a new non-indicating controller of wide range characteristics, designated as Type 2426. The new instrument, made for the control of both temperature and pressure, is of the air-operated type and housed in a molded case. It has a throttling range of from 1 to 15 per cent and in the temperature type has a graduated range of from —30 to 500 deg. F. The pressure type has a graduated range of from 15 to 500 lb. Compensation for room temperature disturbances can be supplied if required.

FOR THE PRODUCTION of preforms of plastic molding materials, Arthur Colton Co., 2600 East Jefferson Ave., Detroit, Mich., has developed a new preforming press of exceptional power and heavy construction. The new No. 14 press exerts a maximum pressure of 10 tons per square inch and can produce a tablet up to 4½ in. in diameter. The total pressure exerted is 150 tons. An important feature of the design is the application of pressure to both sides of the tablet, thereby overcoming die friction and obtaining uniform density throughout the tablet. The toggle action design is such as to allow a longer holding period while on the pressure end of the stroke, thus permitting more air to escape. The press is powered by a 10-hp. motor, operated through a Reeves variable speed drive, and has a capacity of 20 to 35 tablets per minute.

MEASUREMENT of a wide range of flow rates at pressures from 200 to 600 lb. per square inch is facilitated through the use of a multiple-orifice flowmeter of the U-tube type recently announced by the Merriam Co., 1955 West 112 St., Cleveland, Ohio. All parts of the instrument subjected to stress are unusually strong and the front is protected by a heavy shatter-proof glass plate. By loosening the gaskets of the orifice disk, it may be revolved so as to use any of four different sizes of orifice, according to the quantity of fluid being measured.

GAS-TIGHT rubber goggles, so designed as to eliminate fogging, have been announced by H. S. Cover, South Bend, Ind. A little water is placed inside the goggles at the time they are put on. Capillary action and a patented rubber groove are said to keep the water away from and out of the eyes. A shaking motion at the first evidence of fogging is said immediately to remove all clouding and make it possible for the wearer to work almost indefinitely without having to remove the goggles. This same manufacturer has also announced an inexpensive knitted hood which can be drawn over the filter apertures of any respirator using a round, flat aperture for holding the filter pads. When used in heavy dust concentrations, the cover can be removed occasionally and shaken, finally to be discarded after using or laundered, as desired. The protectors are said greatly to add to the life of respirator filter pads.

## Resinous Pitch

NUBA, a new resinous pitch announced by the Neville Co., Neville Island Post Office, Pittsburgh, Pa., is made in three grades divided according to melting point range. It is a dark, thermal-softening plastic of unusual properties, available at low cost. Its outstanding properties are stated to be toughness and elasticity. It is almost entirely soluble in aromatic solvents, and partly soluble in petroleum solvents upon warming. The manufacturer suggest its

use in the rubber industry where it may be used as a compounding agent, filler and softener, particularly in floor tile compounds. Exhibiting less cold flow and less brittleness at low temperatures than do the usual roofing pitches, Nuba is said to be well suited for use in roof coatings. Among other suggested uses may be mentioned the production of a range of "waxes" in combination with paraffin, use as a binder in briquetting, for low priced molding compounds, adhesives and as a component in electrical insulating blocks.

## Combustion Controller

A SAFETY UNIT for automatically and safely lighting the burners of gas-fired ovens and furnaces has been announced under the name of Combustrol by General Combustion Corp., Engineering Bldg., Chicago, Ill. The control eliminates hazards resulting from pilot flame or electrical failure, and, by the addition of simple accessories, can provide against overheating or damage due to fan, drive or motor failure. The unit consists of a pilot thermocouple and control cabinet. A switch is provided which places the unit in operation. The operator then starts the fan, whereupon the instrument takes charge, automatically following a predetermined cycle. First the fan operates for a predetermined time, so as to exhaust the oven of gases or explosive vapors. At the end of this period, the pilot gas valve opens and a spark plug ignites the pilot. The pilot heats the thermocouple and when conditions are correct for safe ignition, the main gas burner valve opens automatically and the burner is lighted. Should pilot flame failure occur or the flow of electricity be interrupted, the gas flame to both pilot and burners is automatically shut off, preventing firing of the oven until safe.

# MANUFACTURERS' LATEST PUBLICATIONS

**Alloys.** Climax Molybdenum Co., 500 Fifth Ave., New York City.—Looseleaf binder containing bulletins totalling 41 pages on molybdenum in gray iron, comprising sections on the general subject, on alloy irons, on alloy combinations, and on applications.

**Dust Collectors.** American Air Filter Co., First and Central Ave., Louisville, Ky.—Form 276—6-page folder describing in some detail construction and operation of this company's Type W water spray dynamic precipitator for separating dusts from gases.

**Electrical Equipment.** Anaconda Wire & Cable Co., Sales Promotion Dept., 25 Broadway, New York, N. Y.—Bulletin C-27—20 pages on non-metallic sheathed cable for direct burial in the ground with descriptions, application information and engineering data.

**Electrical Equipment.** Crocker-Wheeler Electric Mfg. Co., Ampere, N. J.—Bulletins 247 and 249—12-page bulletins, covering respectively alternating-current and direct-current generators, with details of construction and installation photographs.

**Electrical Equipment.** Durakool Co., Inc., Elkhart, Ind.—Bulletin 500—6-page bulletin describing construction, principles and characteristics of this company's metal mercury switch; also Bulletin 501, 4 pages on general operating characteristics and application data concerning this switch.

**Electrical Equipment.** General Electric Co., Schenectady, N. Y.—Publications as follows: GEA-1285A, track-type limit switches; GEA-1569A, brief description of Thrustor operated valves; GEA-2594, brief discussion of dependability of this company's inclosed and explosion-proof motors.

**Enameling.** Porcelain Enamel Institute, 612 South Michigan Ave., Chicago, Ill.—Booklet on production of castings for porcelain enameling, resulting from cooperative effort between foundrymen and the enameling industry.

**Equipment.** C. O. Bartlett & Snow Co., Cleveland, Ohio—Catalog 77—44 pages on crushers, pulverizers, disintegrators, ball mills and feeders, with engineering diagrams, capacity tables, suggestions for use, etc.

**Expansion Joints.** Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.—Bulletin EJ-1906—16 pages with descriptions, installation views and engineering data covering this company's slip-type expansion joints.

**Fire Protection.** Walter Kidde & Co., 140 Cedar St., New York, N. Y.—Folder AD-491—4 pages describing this company's carbon dioxide operated rechargeable fire extinguishers; two types are described, one employing pure water, and the other an anti-freeze solution.

**Hard Facing.** Haynes Stellite Co., Kokomo, Ind.—104-page hard facing booklet, the 4th edition, revised, of this publication, covering in detail the applications of hard facing with Haynes Stellite products.

**Instruments.** Foxboro Co., Foxboro, Mass.—Bulletin 175-1—32 pages on the automatic control of temperature, pressure, level and flow in continuous processes through the use of this company's Stabilog instruments; also Bulletin 212, comprising 20 pages, describing and illustrating the use of the Verigraph moisture controller for controlling paper drying.

**Insulation.** Johns-Manville Corp., 22 East 40th St., New York City—68 page insulation booklet, a new edition of "Barriers to Industrial Waste," serving as a guide for selection of this company's insulations for a wide variety of industrial uses.

**Lubrication.** Shell Petroleum Corp., Shell Bldg., St. Louis, Mo.—48-page book, Vol. 1, No. 4 of a series entitled "Panorama of Lubrication," covering in simple, non-technical fashion the lubrication of diesel engines.

**Lubrication.** The Texas Co., 135 East 42d St., New York City—40 page booklet on the relation of lubrication to efficient paper mill operation, discussing lubrication at every point in the paper mill.

**Management.** E. F. Houghton & Co., 220 West Somerset St., Philadelphia, Pa.—A series of reprints from this company's magazine, "Research, Illustrated," on plant surveys, modern group drive, V-packings and bearing metals and lubrication.

**Materials Handling.** Cleveland Crane & Engineering Co., Wickliffe, Ohio—Form G-437—6 pages on cranes and transfer bridges, illustrated with a variety of actual installations.

**Metals.** American Iron & Steel Institute, 350 Fifth Ave., New York City—14-page pamphlet giving definitions of pig iron and ferro alloys, comprising Section I of a projected steel products manual. Price 15 cents per copy, or less in quantity.

**Packings.** U. S. Rubber Products, Inc., Mechanical Goods Division, 1790 Broadway, New York City—Miniature catalog covering the eleven most commonly used packings made by this company.

**Pipes.** United States Pipe & Foundry Co., Burlington, N. J.—23-page spiral-bound booklet on Super-DeLavaud cast iron pipe, covering advantages, manufacture, specifications and tabulated engineering data.

**Pipes.** Youngstown Sheet & Tube Co., Youngstown, Ohio—First Edition, Waterworks Manual—Loose-leaf manual of approximately 120 pages of practical data regarding this company's special wrapped and lined steel water mains, with much technical information and many engineering data tables.

**Power Generation.** Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago, Ill.—Bulletin 3600-A2, 15 page bulletin describing this company's diesel engine-operated generating sets for direct and alternating current industrial service.

**Power Transmission.** Continental-Diamond Fibre Co., Newark, Del.—4-page leaflet describing this company's Celoron molded plastic coupling for power transmission.

**Power Transmission.** Link-Belt Co., 307 North Michigan Ave., Chicago, Ill.—Bulletin 1622—8 pages on cast iron pulleys for power transmission.

**Presses.** Fred S. Carver, 345 Hudson St., New York City—4 page reprint of an article describing the use of laboratory hydraulic presses in research molding.

**Pumps.** Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago, Ill.—Publications as follows: Bulletin 6205, 8 pages on duplex steam pumps; Bulletin 6920 6 pages on oil lubricated inclosed impeller turbine pumps; Bulletin 6920 R, 6 pages on water lubricated turbine pumps.

**Pumps.** Kinney Mfg. Co., 3529 Washington St., Boston, Mass.—Bulletin 15—15 pages briefly describing this company's variety of rotary liquid and vacuum pumps; also covers other products such as strainers and clutches.

**Pumps.** Roots-Connersville Blower Corp., Connersville, Ind.—Bulletin 260-B 11-C—6-page folder illustrating and describing this company's Type T turbine pumps, with selection data.

**Refractories.** Quigley Co., 56 West 45th St., New York City—Bulletin 320—4 pages describing Insulcrete, this company's lightweight insulating refractory concrete; also leaflet briefly presenting uses and advantages of Hearth-Crete, a material for building refractory monolithic bottoms of furnaces.

**Refrigeration.** Carrier Corp., 850 Frelinghuysen Ave., Newark, N. J.—48-page spiral-bound illustrated book covering this company's centrifugal refrigeration equipment, with description and engineering data; also 12-page book briefly illustrating and describing equipment for industrial air conditioning, refrigeration and space heating.

**Safety.** Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa.—Bulletin CA-3—Leaflet describing this company's H-H Inhalators for treatment of respiratory failure. Also Bulletin FA-57, leaflet describing a new salt tablet dispenser for use in preventing heat sickness.

**Valves.** Cochrane Corp., 17th and Allegheny Ave., Philadelphia, Pa.—Bulletin 2710—16 pages on this company's Multiport relief valves for use where absolute protection against overpressure is needed.

**Valves.** W. S. Rockwell Co., 50 Church St., New York City—Bulletin 371—Leaflet briefly discussing this company's butterfly type blast gates.

**Weighing.** Merrick Scale Mfg. Co., Passaic, N. J.—Bulletin 375—21-page bulletin describing this company's Weightometer, a combination continuous weighing device and conveyor. Gives information on construction and application.

# Chemical Engineering NEWS

## A.C.S. HOLDS CHEMICAL ENGINEERING SYMPOSIA AT ROCHESTER

**Editorial Staff Report**

With registered attendance of more than 3,000 and a program of approximately 500 papers, the 94th meeting of the American Chemical Society, held at Rochester, N. Y., during the week of September 6, centered around a number of interesting symposia. Chemical engineers found of most value the ten papers on unit processes—a program arranged and conducted by Professor R. Norris Shreve of Purdue. A second symposium of the Industrial Division dealt with automatic control. Here Charles Allen Thomas of Monsanto presided. From the former meeting it was most evident that the unit chemical processes as contrasted with the unit physical operations will play a more important part in the future development of chemical engineering, especially in the organic chemical industries.

A symposium on chemical engineering education held under the auspices of the Division of Chemical Education attracted seven papers by leaders in this field. Professor Otto M. Smith, head of chemistry and chemical engineering at Oklahoma A. & M. College, presided. Other popular symposia were devoted to the chemical utilization of petroleum hydrocarbons and to gaseous combustion. Dr. Gustave Egloff's paper attracted wide popular attention for it seemed to link the chemical utilization of petroleum with a plan for producing millions of pounds of T.N.T. and other explosives needed in war. To his credit, it should be pointed out that his original paper did not emphasize the "jingo-ism" that was played up in the newspapers of the country.

President Edward R. Weidlein presided at the joint symposium of the biological, agricultural and food divisions that debated the question: "Are patents on medicinal discoveries and new foods in the public interest?" The answer seemed to be that if properly administered such patents promoted sound development. Dr. Morris Fishbein suggested the creation by the American Medical Association of a holding corporation for the administration of patents on medicinal and health products. Dean H. L. Russell of the Wisconsin Alumni Research Foundation and Dr. George B. Schley of Indianapolis participated in this three-cornered debate.

At the general session on Wednesday in the large Eastman Memorial Theatre, the membership unanimously endorsed the action of the Board of Directors in arranging for the national incorporation of the American Chemical Society. This will open up possible channels of cooperation with the government in event of national emergency and also will significantly lessen the tax burden on certain inter-state transactions of the Society.

The principal speakers at the general meeting were Professor Nevil Vincent Sidgewick of Lincoln College, Oxford, England, on "The Uniqueness of Carbon" and Dr. C. E. K. Mees, vice-president and director of research of the Eastman Kodak Co., who interestingly described and demonstrated recent developments in color photography. This versatile gentleman also presided at the banquet held in the plant of the Bausch & Lomb Optical Co., where the principal speaker was one, "Sir James Alexander" who in real life is John E. Daniels of the Associated Industries of Massachusetts.

The next meeting of the American Chemical Society will be held in Dallas, Texas, April, 1938.

### Commercial Solvents Extends Its Alcohol Business

Commercial Solvents Corp. has acquired the industrial alcohol business of the American Commercial Alcohol Corp. and its subsidiary the American Distilling Corp.

American Commercial Alcohol Corp. is withdrawing from the general sale and distribution of industrial alcohol to devote its facilities to the business in beverage spirits.

### National Safety Congress In Kansas City

At the 26th National Safety Congress which will be held at Kansas City, Mo., Oct. 11-15, the program calls for the Chemical Section to meet at the President Hotel for luncheon on Oct. 12. William P. Yant, Mine Safety Appliances Co., Pittsburgh, will be the luncheon speaker. In the afternoon, H. L. Miner will act as general chairman with a business meeting scheduled, including committee reports, election of officers, and presentation of awards for the Chemical Section safety contest. A. B. Ritter, Hercules Powder Co., Wilmington, will also deliver an address.

### Du Pont to Erect Sulphide And Cellophane Plants

A new plant for the manufacture of carbon bisulphide will be built for E. I. du Pont de Nemours & Co. at Bellwood, Va. It is reported that the plant will be operated by the Old Hickory Chemical Co., a du Pont subsidiary. It is also reported that work is well advanced on the addition to the du Pont rayon plant at Ampthill.

The du Pont company also is reported to have purchased a tract of 400 acres at Clinton, Iowa, on which will be erected a new plant for the production of cellophane.

# PREPAREDNESS PROGRAM AND RESEARCH AID BRITISH CHEMICAL INDUSTRY

By PAUL WOOTON
**Washington Correspondent**
**McGraw-Hill Publications**

IMPROVEMENT of its mechanical equipment and expansion of research are outstanding developments of 1937 in the British Chemical industry. It is realized that the present boom must subside. To prepare for the day when the volume of business will be less and competition more, nothing is being left undone to reduce costs.

The chemical industry in the United Kingdom is benefiting greatly from armament and building programs. The armament program, incidentally, is not responsible for the upturn in explosives production. Mining and peace-time uses are the principal sources of orders. Capacity to produce explosives in an emergency, however, has been expanded greatly. War in the future will require larger proportionate amounts of explosives, not only due to increased use of artillery but to requirements for depth bombs, as a protection against submarines, and for bombs dropped by airplanes.

One of the principal lessons the British learned from the World War was the imperative necessity of having a highly developed chemical industry. More than that, concentrated industries of the chemical type fit perfectly into British economy. For these reasons it has been stimulated and encouraged, directly and indirectly by the government. It provides the means for greater utilization of coal and other domestic raw materials.

Before the war the British chemical industry frequently showed lack of enterprise. For instance, the first coal-tar dye was made in England but the industry was allowed to develop in Germany. Antipathy to change is a part of the psychology of the British people. The very essence of chemistry is change. To go to the coal mine for materials for plastics to supplant forest products was not the sort of thing that fired the Briton's imagination. But when national necessity became apparent the British took up chemistry in a big way. To have something comparable with the I. G. Farbenindustrie they combined the British Dyestuffs Corp., Brunner Mond and Co., Nobel Industries, the United Alkali Co. and some forty other concerns to form the Imperial Chemical Industries, Ltd. with plants throughout the Empire to say nothing of operations in Palestine, Brazil, and elsewhere.

Despite its £72,000,000 of capitalization and the wide range of I. C. I. activities there are literally thousands of other companies in the United Kingdom engaged in the manufacture of chemicals and allied products.

The housing program under which 300,000 family units are provided annually call for large quantities of nonferrous metals, paint, lime and other products of chemical plants. There has been a notable expansion in manufacture of chemical building materials.

**J. Davidson Pratt**

**General manager and secretary of the Association of British Chemical Manufacturers.**

At the offices of the Association of British Chemical Manufacturers this correspondent found chief interest centered at the moment in the Factories bill which at that time was in a critical stage in its legislative course. There was nothing in the principle of the bill to which the association objected. It required constant vigilance, however, to prevent the adoption of impractical methods.

Among the provisions of the act that concern the chemical industry particularly is the requirement that vessels or sumps containing corrosive or poisonous liquids should be adequately fenced. Sufficient openings or means of egress must be provided for tanks or chambers in which dangerous fumes are liable to be present.

This writer found sentiment in England to be strongly in favor of a reciprocal trade agreement with the United States. This was just as true among chemical manufacturers as it was among government officials. Francis D'Arey Cooper, chairman of Lever Brothers is convinced "that international commerce is straining at the leash and only political folly holds it back." J. Davidson Pratt, general manager and secretary of the Association of British Chemical Manufacturers told this writer that there is no point in having British and American chemical industries waste energy in cutting each other's throats. He thinks trade can be developed on a complementary basis.

There are very few chemical products upon which British manufacturers have a monopoly of the home market. Products of which imports are less than five per cent practically are limited to: Sulphuric acid, nitric acid, salicylic acid, ammonium carbonate, barium compounds, bleaching materials, copper sulplate, caustic soda, zinc oxide, paints, varnishes, disinfectants, insecticides and coal tar intermediates. Imports of chemicals this year are at the rate of £25,000,000. While principal British purchases in the United States are confined to sulphur, carbon black and naval stores there is a long list of chemical manufactures which move in smaller quantities. In all the movement may reach $12,000,000 in 1937. On the other hand chemical purchases of the United States in the United Kingdom aggregate about half the latter amount.

It is in mutual concessions applying to a wide range of small interchanges that the trade agreement is expected to get its start.

Neville Chamberlain, the British premier, like Cordell Hull, believes that the absorption of unemployment and the expansion of industries in manufacturing countries depend upon raising living standards in the less-developed countries. This involves lending money. The British, always bold in making foreign investments, are convinced that ways ultimately will be found for restoring confidence that will make the resumption of such loans possible. Creditor countries can cooperate to that end, it is argued, particularly in arranging for the floating of a part of each loan in more than one country. Default is not so likely when two or three powerful creditors will suffer. The chemical industry would be among the principal beneficiaries of increased buying power in countries with lower living standards.

Research always has had an important place in the British chemical industry. The proportion of expenditures for that purpose is larger in 1937 than ever before. One company, the ICI, is using a million pounds a year for that purpose. Neoprene, alone, it is claimed, promises to justify total research expenditures. ICI chemists avoid calling it artificial rubber. It is finding the same applications in industry as the German Buna and has the same properties of resistance to abrasion, heat, oils and acids. Its oil resistance is five times that of rubber.

# NEWS FROM WASHINGTON

**Washington News Bureau**
**McGraw-Hill Publishing Co.**
**Paul Wooton, Chief**

UNIONIZATION of chemical plant workers by C.I.O. will be undertaken shortly. This effort will be directed by James Nelson, president of District 50, United Mine Workers, and present head of the chemical unit which includes coke and byproduct workers.

Press estimates that this drive has a goal of one-half million members seem unwarranted. Union headquarters claim only 300,000 workers in the chemical group of industries under consideration. This includes coke and gas, paint and varnish, plastic, solvent, heavy chemical, dye, tar products, and a number of related groups. Petroleum refinery workers and drug and pharmaceutical employees are tentatively classified elsewhere.

Legislation desired by the President remained largely in the Congressional mill on adjournment in mid-August. But many of the measures of reform or regulation advanced so far as to make enactment at the next session seem almost certain.

Standards for labor, fixing minimum wages, and maximum hours of work, will have consideration immediately after a general agricultural control bill. The date of enactment depends importantly on when Congress reconvenes. The scope of these and other measures will be more largely determined by what constituents back home are saying to Congressmen this fall.

If voters give the members of Congress the impression that they want the President's bills pushed through in most rigorous form, they will be. If the voters are tired of reform measures, then very modest legislation can be expected. The influence of the constituents on Congressional judgment has not been greater for a decade.

### Food and Sugar

The proposed revision of the Food and Drug Law was not completed. Delay in final enactment was caused primarily by Congress' inability to decide how much authority the Federal Trade Commission should have, particularly the desirable limitations on advertising control. That question will be settled next winter, and then a food and drug law in harmony with the decision will pass. So far as technical and non-advertising features are concerned, the terms of the Copeland bill as it now stands before the House probably will prevail.

Sugar legislation resulted, according to the President, from an "unholy alliance" of refiners and domestic beet and cane growers. The President intends that Congress break this cooperative lobby; and he even expressed the hope that the present advantages to domestic refiners will be repealed before the normal end of the period to which the new law applies (about three years).

The President stated that the sugar refiners impose excessive and unreasonable burdens on the price of sugar for household use. He did NOT explain that the federal taxes on sugar are more than six times as much as the total cost of refining and the profits received. Defenders of the sugar industry are expected to explain to Mrs. Housewife that they get a small fraction of a cent, but Uncle Sam takes several times as much.

Fortunately for alcohol, the proposed tax on molasses was eliminated from the sugar bill in conference. But in the House the food and drug bill still holds the twin threats: (1) That only grain alcohol may be used in beverages; and (2) that non-beverage alcohol may be taxed just as are the beverage uses. Next winter Congress will settle these items.

### New Helium Law

The Bureau of Mines becomes, in effect, monopoly producer of helium under the law passed at the end of the last session of Congress. This Government agency is authorized to purchase on an appraisal mutually agreed to, the helium facilities of the only commercial helium producer, a division of Girdler Corporation. Thereafter it will be the only going enterprise recovering helium for sale.

As in the past, the Bureau will supply the Army and Navy and other government agencies on requisition at cost plus a nominal overhead. In addition, the Bureau may sell helium commercially. It is provided, however, that if the helium so sold is to be exported, or used in international aircraft flights, a permit for such use outside of the United States must be obtained from the National Munitions Control Board, of which the Secretary of State is chairman.

Bureau officials hope this new law will permit somewhat increased activity at the Amarillo Station of the Bureau. Slightly more convenient arrangements will be possible in the marketing of helium for domestic use in lighter-than-air craft. But no boom in the helium market is anticipated, unless the proposed trans-Atlantic airship service can be established by joint efforts of German and American capital. The availability of helium may help a little there, but the important thing is that the new air carriers get suitable maritime subsidy or mail contracts.

### Czech Trade Treaty

In one of the first formal promulgations under the new practice of trade agreement negotiation, the State Department has announced a list of commodities on which it is considering tariff adjustments in its deal with Czechoslovakia. Chemical industries are noting that decolorizing and deodorizing carbon, potassium permanganate, glass and glass products, and certain types of china, porcelain, and related ware, are included. The State Department has announced the way in which it will receive presentation of views regarding these commodities. It is definitely stated that commodities not on this list will not be considered for tariff adjustment in these negotiations unless further notice is given.

Stiffening of the United States trade regulations was announced by Treasury officials during August. New countervailing duties against nine countries that subsidize goods imported into the United States have been announced. Thus far, most of the commodities so affected are foods or other agricultural products. Executives in other industries apparently are trying to determine whether similar protection against imports can be imposed to help them in meeting competition of commodities that are virtually Government controlled abroad.

### Stream Pollution

Restriction in discharge of industrial wastes into the rivers will be imposed by legislation sure to pass next winter. The Vinson bill, passed by the House months ago, finally escaped the Senate committee deadlock during August, but died in conference through lack of time to adjust differences.

When enacted this bill will charge the Public Health Service with investigation, fixing of standards, and enforcement. The Senate idea of definite purity standards for water supply will probably prevail. But from three to five years will be allowed for industry to adjust its operations to the standards fixed, if the more conservative legislators have their expected influence.

The pressure of public opinion, and the desire of municipalities to get good water supply from streams at a minimum cost for the treatment, are expected to keep the Public Health Service regulations aggressively functioning when the law is passed.

# JAPAN'S CHEMICAL INDUSTRY DEPENDENT ON IMPORTED MACHINERY

Special Correspondence

GROWTH of the chemical industry in Japan during recent years has been remarkable and has become self-sufficient as to many heavy and light chemicals, acids and alkalis, fertilizers, explosives, etc. Japan no longer imports sulphuric and nitric acids, its imports of ammonia and dyes have been decreasing apace, it exports a large quantity of rayon and other chemical fibers, and its explosives, glass and other products find their way into Asiatic markets.

So far as chemical machinery is concerned, however, it still depends largely on foreign systems, designs and equipments. Its synthetic ammonia producers numbering a dozen, with a single exception, employ foreign systems such as the Claude, Casale, Fauser, Mont Cenis and N.E.C., and all existing contact sulphuric acid plants are equipped with imported machinery such as the Tentelew, Manheim, Schroder-Grillo, Lurgi, Monsanto and Selden. In soda manufacture, the Solvay and Zahn are dominating.

Noboru Nagamawari, assistant professor of Tokyo University of Engineering, is studying this matter and has published his investigations concerning what vital chemical plants are being imported and how these may be produced within the country. Recently, he wrote an article in a book compiled by the university which is entitled "Analysis of New Industries," and enumerates some big chemical plants which Japan has imported during recent months.

His report follows in substance: According to my investigation, Japan continues to import a very large volume of chemical machinery from Germany, the United States, England and other countries, and some 10 plants, each costing more than one million yen, have been imported during the past several months. Notable among these are the Lurgi's coal liquefaction plant imported by the Korean Nitrogenous Fertilizer Company, and the following various plants: Dubbs cracking plant, by Mitsubishi Petroleum Co.; Power-Gas Corp.'s gas producers, by Korean Nitrogenous Fertilizer Co.; Linde's gas producers, by Showa Fertilizer Co. and Ube Nitrogenous Fertilizer Co. Knowles's electrolytic cells, by Yabase Engineering Co. Monsanto's sulphuric acid contact plants, by Toyo High Pressure Engineering Co. and Toryu Chemical Co.; Lurgi's sulphuric acid contact plants, by Nippon Dye Mfg. Co. and Nippon Soda Co.; Bemag-Meguin's nitric acid concentrating plant, by Yabase Engineering Co.

Japan's chemical industry is growing rapidly in all directions, and many branches of chemical manufacture already suffer from over production with the prospect of being shaken to the foundation unless surplus output be consumed by export trade. But it is not an easy proposition to dispose of the mounting surplus stock in the markets abroad. The only way out is to restrict production within the limits of domestic consumption and to export chemical machinery, instead of chemical products, to the countries where their own production must be increased.

### Synthetic Resin Industry

Synthetic resins have come to the fore in Japan with the development of the electric industries, in which they are widely used. Their quality, however, fails to keep abreast with the rapid stride in electric engineering technique. All the products so far offered lack certain important properties, although they are excellent with regard to certain other characteristics.

Tetsuro Haniu, engineer in the electro-chemical laboratory of the Communications Ministry, reviewing the present condition of the Japanese resin industry says in substance: the so-called 100 per cent phenol resin, which is soluble in drying oils, is produced by the Nippon Bakelite Co. Being a condensation product of alkyl phenols and formaldehyde just as are the Albertol of Germany or the Bakelite XR-254 of America, it is soluble in linseed oil, wood oil and other drying oils, and its coating is hard, tensile and resistant to water, acids and alkalis. Even after immersion into water for 24 hours, its insulating property does not drop off more than 25 per cent.

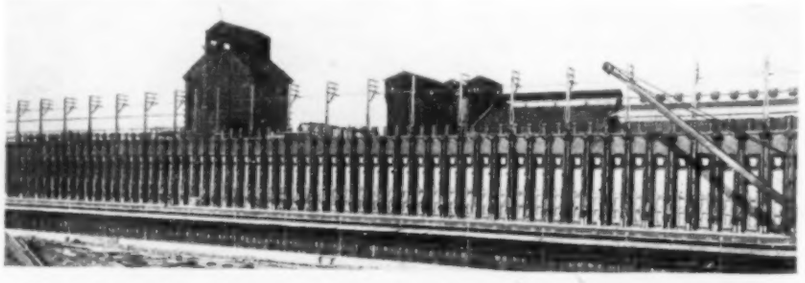
The phenol resin for plastic purposes was developed by Dr. Toshozo Sugimoto of the Osaka Industrial Experiment Laboratory of the Ministry of Commerce and Industry. His product (Japanese Patent No. 830,650) was condensed from hexamethylene-tetramine-triphenol obtained as a result of his experiments on the chemical reaction of phenols on formaldehyde under the catalyzing influence of ammonia. It is resistant to water and acids, and has high tensile strength and insulating property. According to the author's test, it has a dielectric constant of 22,000-24,000 v/mm and a tensile strength of 500-550 kg/sq.cm.

Urushiol, the essential ingredient of Japanese lacquer, urushi, is a unique insulating material. But its application to electric machinery, radio sets, etc., had been limited until its hygroscopic property was eliminated by mixing it with hexamethylene-tetramine. The mixture, when condensed by the usual method, is non-hygroscopic to a remarkable extent and offers the best quality of baking varnish for electric instruments. Research is being conducted by many Japanese scientists with a view to developing some synthetic resin from the solution thus condensed.

Mr. Haniu himself has been making a study of the synthetic resin to be obtained by the condensation of the mixture of alkyl resins with aconite acid and ethylene glycol. His product has approximately equal properties with those of the alkyl resin developed by Mr. R. H. Kienle of the General Electric Company of America. It may be coated over enameled wires.

Vinyl and styrene resins are also the object of intense research in Japan, although no tangible success has been attained to date. There is, perhaps, no single laboratory in the country that tackles the acrolein and acryl groups.

There are, however, several firms which have been engaged in the condensation of olefine polysulphide, all chemically combining olefine chlorides and sodium polysulphide so as to obtain a kind of artificial rubber. Two firms have already succeeded in turning out this product on a commercial scale. The one is the Furukawa Electric Company which discovered the "Thionites," the other being the Fujikura Electric Cable Company, whose product is known by the trade name of "Hydrites."



**New battery of 73 coke ovens recently placed in operation by Tennessee Coal, Iron and Railroad Co., at Birmingham, Ala., will produce daily: 1,110 tons of furnace coke, 20,263,000 cu. ft. of gas, 14,771 gal. of tar, 17.7 tons of ammonium sulphate, 5,207 gal. of light oil, and 3,123 gal. of motor benzol**

## GERMAN COMPULSORY LABOR AND MILITARY SERVICE CREATES SHORTAGE OF CHEMISTS

**From Our German Correspondent**

THAT 60 per cent of the proposals made under the Four-Year plan for inventions and new and substitute products are useless was announced in Berlin recently before a technical journalists' conference arranged by the Bureau of Raw and Structural Materials headed by Colonel Loeb. In addition to numerous industrial and educational institutions carrying on research, private inventors are encouraged, with government subsidy and new regulations facilitating filing of patents, to develop new products which might help to free Germany from the necessity of imports. As a result, government offices and industries are flooded with suggestions ranging all the way from "crack-pot" theories to serious inventions. The government has finished investigating the first 2,000 proposals made by inventors. Of these, 60 per cent were predicated as "worthless," 30 per cent as "stimulating," and 10 per cent as "valuable."

I. G. Farben has donated 650,000 RM during the past three years to support the foundation "I. G. Chemikerhilfe," which grants fellowships to unemployed chemists, according to a report to the 50th annual meeting of the Verein Deutscher Chemiker in Frankfurt. This grant, administered jointly by I. G. and the central clearing office for employment of chemists and physicists has given scholarships to 379 older chemists, and through additional training and vocational rehabilitation, 61 per cent of them found employment.

Statistics of the clearing office reflect the growing shortage of chemists in Germany with only 280 university-trained chemists registered as unemployed at the end of April. Of these, the larger number, especially in the organic and inorganic fields, was over 45 years old, while only 87 persons under 35 years were unemployed or employed with incomes below 200 RM monthly. The shortage of young chemists is becoming more acute as the effect of the one-half year compulsory labor service and two-year military service is reflected in the number of German chemistry students enrolled at the universities, which dropped from 3,216 to 2,810 from 1935 to 1936, while the number of foreign chemistry students increased from 404 to 538. Average age for beginning university chemistry study is thus going up to 21 and 22 years, an age at which, in America and England, most students are completing their courses. Another cause for concern is the shortage of laboratory assistants and instructors at the universities, for the incentive to enter more lucrative industry is strong; four-fifths of the 200 instructors leaving universities last year were engaged by large concerns employing over 25 chemists, which also absorbed two-thirds of the graduates. Although the present demand for chemists cannot be filled for several years, care is taken to avoid future inflation of chemistry students and an overcrowding of the profession as in post-war years.

A plant to treat 30 to 35,000 cu. meters of coke oven gas hourly to recover sulphur has been established at the Augusta Viktoria Hüls mine to increase the domestic output as the production of synthesis gas for the manufacture of synthetic gasoline increases. Even though crude sulphur imports rose last year, Germany expects to attain self-sufficiency soon. The share of the United States, formerly Germany's chief supplier, dropped from 66 to 48 per cent of the total imported sulphur from 1935 to 1936. In 1936 Italy supplied 34,569 tons, the United States 34,499, and Norway 2,172 tons. Low-grade domestic pyrite production increased considerably as a source of sulphuric acid as the Spanish war decreased shipments from Spain.

A selling organization of German sulphur producers has been founded in Frankfurt under the corporate name of "Schwefel G.m.b.H." with a membership of 11 concerns, including I. G. Farben, Braunkohle Benzin A.G., Kali Chemie, and others.

Considerable interest is being shown in Germany for the second America study trip for German chemists from Oct. 26 to Nov. 19, arranged under the auspices of the Dechema and Verein Deutscher Chemiker. The itinerary will begin with a reception in the McGraw-Hill building in New York and will include visits to leading chemical plants and scientific institutions in New York, Boston, Detroit, Chicago, Pittsburgh, Washington, Wilmington, and Philadelphia.

Production of the American developed "Thiokol compounds" the trade name for a number of olefin-polysulphide reaction products with rubber-like qualities, has been undertaken by the "Thiokol G.m.b.H." in Saarau, Silesia.

An innovation in this field which has been widely advertised is the acetylene-base synthetic gutta percha (marketed under the name of "Guttasyn" by the firm H. Rost & Co., Harburg, Wilhelmsburg). The technical possibilities of this product, designed to supplant rubber in hose and tubing, have not been completely studied, but it is not affected by concentrated acids like hydrofluoric and phosphoric, diluted inorganic acids (storage battery acids, sulphuric sp.gr. 1.4), concentrated lyes, water (hydrogen peroxide 30 per cent, seawater), dibasic organic acids, oils and fats, hydrocarbons (benzine, petrol, petrol-ether, etc.) higher fatty acids, glycerine, illuminating gas, sulphur dioxide, chlorine gas. It is affected, however, by concentrated inorganic acids (sulphuric 1.85, nitric 1.4), high percentage alcohols, chloroform, benzol, toluol. Tests show that "Guttasyn" can be used in temperatures from —30° to + 110° C., is non-flammable, and does not oxidize or become brittle with age. The new material can be worked on a lathe, and products made from it include hoses, tubing, washers, valves, membranes, etc.

### Chemical Companies in New Financing Arrangement

The Victor Chemical Works has embarked on a financing proposition which involves the offering for public sale of 150,000 shares of the company. Of these shares 75,000 represent new financing and 75,000 acquired from present stockholders.

Proceeds from the sale of the 75,000 shares being offered for the account of the company will be used in the amount of approximately $1,000,000 for the acquisition of real estate and construction of an electric furnace and chemical plant at Mount Pleasant, Tenn., which will add substantially to the company's capacity to produce phosphoric acid.

The Harshaw Chemical Co. has filed with the Securities and Exchange Commission a statement registering 59,458 common shares of the company. The registration statement also covers 118,915 subscription rights entitling present stockholders to purchase the registered shares at the rate of one additional share for each two shares owned. The unsubscribed portion of the shares registered will subsequently be offered publicly.

Net proceeds will be used to retire bank loans of approximately $650,000, to make plant and laboratory additions and improvements requiring about $500,000, to acquire inventories, and for other corporate purposes.

Air Reduction Co., Inc., also has had listed 36,790 shares of its common stock. This is in connection with the acquisition of Crystal Carbonic Laboratory, Inc., and Crystal Carbonic Laboratory—both subsidiaries of Coca Cola.

Payment will be made in common stock of the company, 34,561 shares being paid for Crystal Carbonic Laboratory, Inc., and 2,229 shares for Crystal Carbonic Laboratory. Both of the companies are manufacturers of liquid carbon dioxide.

## LATEST CENSUS FIGURES SHOW GROWTH IN BRITISH CHEMICAL PRODUCTION

From Our London Correspondent

FURTHER statistics gathered from the chemical and allied trades as a result of the Fifth Census of Production (1935) have been published by the Board of Trade. They show that the gross value of output for chemicals, dyes, drugs, fertilizers, disinfectants, glue, ink, gum, etc. amounted to £67,324,000, which is an increase of £4,617,000 over that of the previous Census (1934). The production of "fine chemicals" decreased from 19,661,000 pounds to 17,218,000 pounds, but due to an increase in market prices the value was slightly more than that for the previous year, which was £1,470,000.

During July the Board of Trade issued an additional list of fine chemicals which will be subject to duty at 33⅓ per cent ad valorem under the Safeguarding of Industries Act, from August 19. This list includes mandelic acid and its ammonium salt (which is now an established therapeutic agent), cyclopropane (a new anaesthetic which shows good results), magnesium stearate, hydroxycitronellal acetals, and butyl glycol and its esters.

Some epoch-making remarks about the use of aminobenzene-sulphonamide, from a medical aspect, were made by a research worker, Dr. W. J. C. Dyke, at the annual British Pharmaceutical Conference which was held at Liverpool at the end of July. Earlier in the month the Society of Chemical Industry held its annual meeting at Harrogate, when Lord Leverhulme was re-elected president for the ensuing society year.

The market for industrial chemicals remains fairly stable in the United Kingdom. Of American interest is the fact that new business for cresylic acid is still rather scarce, even in respect of the American duty-free product. An increase of 5s. to 7s. 6d. per cwt in the price of Rochelle salt was announced by British makers at the middle of July, in consequence of a dearer market for the raw materials. The average price for sulphuric acid has also advanced to the extent of 5s. per ton in the case of B. O. V., and 7s. per ton for R. O. V., but this increase will affect a very small number of users immediately as the bulk of the acid is sold under contracts which normally expire at the end of the year. The principal cause of the rise in price is said to be an increase in overseas freight on pyrites. Sulphate of ammonia prices have also been increased for delivery to farmers in the course of the forthcoming season.

The Distillers Co., Ltd., has decided to reconstruct Cambus Distillery, which was destroyed by fire in 1914. At the recent annual meeting it was stated that the demand for industrial alcohol has increased during the past year, and that the present low cost of production has given exceptional facilities for new manufacturers to be started up in the United Kingdom. The market for carbonic acid gas also shows development, more especially in respect of the solid "dry ice" which is sold under the company's brand name of "Cardice." British Glues and Chemicals, Ltd., has also recently held its annual meeting, when it was pointed out that there has been a substantial shrinkage in world glue stocks and that the company looks forward to a continued good demand in the home and foreign markets.

According to the annual report of the Colour Users' Association the level of present-day dyestuff prices is considered to be far too high by comparison with pre-war prices. So far as certain products of the specialty type are concerned it is stated that the absence of competition has had its effect in promoting the present position. The question of the price of benzol to the dye-making industry, and also the manufacture of pure anthracene in the United Kingdom, are problems which have recently engaged the attention of the Dyestuffs Industry Development Committee.

Modern Fuels, Ltd., a new company, has purchased the coal-oil works at Seaham Harbour, formerly owned by Coal and Allied Industries, Ltd., and when reconstructed the plant may be in operation again before the end of the year, after lying idle for six months.

Oil prospecting in the United Kingdom has now involved the issue of 69 licenses, covering an area of 11,350 square miles, under the Petroleum (Production) Act 1934. The companies concerned are D'Arcy Exploration Co., Anglo-American Oil Co., Midlothian Petroleum Syndicate, Steel Bros. and Co., and Gulf Exploration Co.

New "chemical" companies registered in London during the first six months of 1937 numbered 274, with a total capital of £1,242,624, and of these all but four—with a total nominal capital of £115,100—were private companies.

## CALENDAR

AMERICAN GAS ASSOCIATION, annual convention, Cleveland, Ohio, September 27-October 1.

CHICAGO EXPOSITION OF POWER AND MECHANICAL ENGINEERING, International Amphitheater, Chicago, Ill., October 4-9.

ELECTROCHEMICAL SOCIETY, fall meeting, St. Louis, Mo., October 13-16.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, fall meeting, Savannah, Ga., October 18-20.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, Iron and Steel Division and Institute of Metals Division, Atlantic City, N. J., October 18-21.

AMERICAN WELDING SOCIETY, annual meeting, Atlantic City, N. J., October 18-22.

AMERICAN PETROLEUM INSTITUTE, annual meeting, Chicago, Ill., November 8-12.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting, St. Louis, Mo., November 17-19.

16TH CHEMICAL EXPOSITION, Grand Central Palace, New York City, December 6-11.

AMERICAN CHEMICAL SOCIETY, semi-annual meeting, Dallas, Texas, April 18-21, 1938.

### Japan Developing New Source of Iodine

A new company capitalized at $150,000 has been organized in Japan for the purpose of recovering iodine from subterranean brines which occur in the natural gas area of Otaki and vicinity, according to reports from Trade Commissioner Paul P. Steintorf, Tokyo. The organization, which is a subsidiary of the Otaki Natural Gas Co., will utilize a process developed by the Physical and Chemical Research Institute. Heretofore Japan has obtained its iodine supply from seaweed or "kelp" and has produced more than enough to satisfy the domestic demand from that source.

It is believed that the new company will produce for export, particularly in view of the iodine cartel agreement entered into some time ago between Japanese and Chilean producers. Under the terms of this agreement, which was ratified on June 10, it is understood that Chile agrees not to sell iodine in the Japanese Empire, and Japan is allotted an export quota of 70 metric tons per annum, which is subject to revision every three months in accordance with fluctuations in demand.

It is not believed Japan will be able to fill its export quota in the immediate future as its current output is probably under that figure—a little more than 36 metric tons was produced in 1934.

# PERSONALITIES

✦ A. A. BATES recently joined the staff of the Westinghouse Research Laboratories as manager of the chemical and metallurgical division. Previously he had been employed by the National Tube Co. and was also research metallurgist for the National Malleable and Steel Casting Co. He is a former professor of metallurgy at Case School of Applied Science.

**A. A. Bates**

✦ FIRMAN E. BEAR, formerly director of agricultural research for the American Cyanamid Co., has been appointed scientific editor of the *Country Home* magazine.

✦ ALFRED CLARK has been made a member of the technical staff of Battelle Memorial Institute. He has been assigned to the division of applied chemistry and will work in the field of synthetic organic chemicals.

✦ M. I. DORFAN, former manager of the dust division of the Blaw-Knox Co., is now employed by the Pangborn Corp. as general field representative specializing in dust control. The dust control interests of the Blaw-Knox Co. have recently been taken over by the Pangborn Corp.

✦ WAYNE Z. FRIEND has been added to the development and research staff of the International Nickel Co. During the past seven years Mr. Friend has been associated with the Phillips Petroleum Co. as chief technologist of its Philgas department.

✦ GEORGE P. GRAY, a former chief of the chemistry division of the California State Department of Agriculture, has been made secretary and general supervisor of fertilizer production at J. A. MacDonald, Inc., Los Angeles.

✦ JOHN R. HUFFMAN this month begins his duties as assistant professor of chemical engineering at New York University. Last year he received his Ph.D. from Columbia University where he was associated with the development of the revolving disk fractionating column for separation of oxygen isotopes. To sports followers Dr. Huffman is well known as the American national three-weapon fencing champion. He has been a member of the last three Olympic teams.

✦ KLARE S. MARKLEY has been transferred from the Washington offices of the Bureau of Chemistry and Soils to head the oil section of the soybean laboratory of that bureau at Urbana, Ill.

✦ DANIEL F. MORTARA has been added to the chemical engineering staff of D. W. Haering & Co., Inc., Chicago.

✦ A. U. SEYBOLT, Ph.D. Yale 1936, has been appointed to the technical staff of the non-ferrous metallurgy division of Battelle Memorial Institute. He will be engaged in work on copper-base and lead-base alloys.

✦ CARL L. SIEGEL, formerly chemical engineer for A. G. McKee & Co., Cleveland, has accepted a position with Sharples Solvents Corp. at Wyandotte, Mich.

✦ E. BRIGHT WILSON, JR., assistant professor of chemistry at Harvard University, has been awarded the 1937 American Chemical Society prize of $1,000 in recognition of his work in physical chemistry. The award is made annually to an American chemist under 31 years of age who has done outstanding research in pure chemistry.

✦ ROBERT P. RUSSELL has been appointed executive vice-president of the Standard Oil Development Co., and,

**Robert P. Russell**

under F. A. Howard, president, will assume general executive responsibility in the company. Dr. Russell is familiar to the profession as co-author with R. T. Haslam of the book "Fuels and Their Combustion."

## OBITUARY

✦ H. E. ARMSTRONG, often named as the most prominent figure in British chemistry, died last month at the age of 89. He was a senior Fellow of the Royal Society.

✦ EUGENE MERZ, retired president of Heller and Merz Corp. and vice-president of Calco Chemical Co., died September 5 at his home in Florham Park, N. J. He was 68 years of age and had spent 40 years in active association with chemical and dyestuff manufacture.

✦ ALEXANDER G. MCKENNA, chairman of the board of directors of the Pomona Pump Co., Pomona, Calif., died July 29. He was 72 years of age, and during his lifetime was intimately connected with metallurgical developments in the steel industry.

✦ HORACE W. HOOKER, vice-president, treasurer and director of the Hooker Electrochemical Co., died August 30 at the age of 60.

✦ ALLISON BISHOPRIC, president of the Natural Sodium Products Co. Ltd. of Cincinnati, Ohio, was killed in an automobile accident on August 31.

# Chemical ECONOMICS and MARKETS

## CONSUMPTION OF CHEMICALS DECLINED THROUGHOUT SUMMER MONTHS

ACCORDING to the report of the Federal Reserve Board, there was very little change in the status of general industrial production in July as compared with the totals for the preceding month. The report stated that total volume of industrial production and distribution of commodities to consumers showed little change from June to July, when allowance is made for the usual summer declines. Without seasonal adjustment, however, a 3-point drop is noted.

The board's seasonally adjusted index of industrial production was 114 per cent of the 1923-1925 average in July, the same as in June and 4 points lower than in March, April and May.

Factory employment increased somewhat from the middle of June to the middle of July, when a decline is usual, and factory pay rolls decreased less than seasonally. The largest increases in employment were in the steel industry and in the food industries, particularly at canning factories. Other manufacturing industries as a group showed somewhat less than the usual seasonal decline.

July sales of both manufacturers and wholesalers showed substantial increases over the same month last year, according to a survey by the Bureau of Foreign and Domestic Commerce. Total net sales of 522 manufacturers in 15 industries registered an increase of 7.8 per cent during the month over July of last year.

The position of the more important chemical-consuming industries clearly indicates that consumption of chemicals in July fell off materially from the totals of the preceding month. In the first place, a marked decline was reported in textile manufacture. Consumption of cotton dropped from 681,000 bales to 583,000 bales in July. Silk consumption, measured by mill deliveries showed a total of 35,783 bales for June and 31,399 bales for July. Consumption of apparel class raw wool averaged 4,102,000 lbs. weekly during July, as compared with a weekly average in June of 5,020,000 lbs. Consumption of carpet class raw wool averaged 1,581,000 lbs. weekly during July, compared with a weekly average consumption of 2,378,000 lbs. in June.

In the glass industry, production of containers held up very well in July but other branches made a less favorable comparison. The output of plastics, artificial leather, denatured alcohol, explosives, and fertilizers also showed seasonal declines.

On the other hand, byproduct coke ovens extended their operations with larger yields of crude coal tar, light oils, ammonia, and benzol. Producers of wood rosin and turpentine likewise were more active and the same was true for synthetic methanol production which is on its way to an all-time record this year.

The comparison for July and June is substantially true of a comparison of productive activities in July this year with those of July last year. This indicates that percentages of gain reported for the chemical industry for the first half of this year, were somewhat lowered by the drop in July operations.

While production of cellulose plastic products has increased considerably this year, it develops that this is not due entirely to expansion in domestic consumption. Steady and remarkable gains in exports of American plastic bases and materials for use in fabrication of products abroad, came to a total of 9,500,000 lbs. with a value of $3,413,000 during the first half of the current year, a jump of almost 3,000,000 lbs. over the figures for the same period in 1936. Pyroxylin film support also known as "celluoid" film base led the export list, according to official figures. Shipments in that group totaled 1,985,600 lbs. for the six months period as compared with 1,186,000 lbs. last year.

July fertilizer tax tag sales in the 12 reporting Southern States amounted to 58,226 tons, according to The National Fertilizer Association. This was approximately one-third more than in July of last year and was substantially above July, 1935. In the southern and midwestern areas the sales for the month of July are ordinarily a very small part of the year's total. In the past several years July tag sales in the South accounted, on the average, for only 0.6 per cent of the year's total, while in the Midwest the July ratio has been 0.9 per cent.

Sales in the South in the first seven months of this year totaled 4,707,851 tons, compared with 3,689,052 tons last year. This represents a gain of 28 per cent over the corresponding period of 1936. Increases were reported by all 12 States.

Foreign trade in chemicals and related products has made a good showing this year although in a few instances export tonnage has been adversely affected by inability to negotiate freight space at satisfactory price levels. Both the outward and inward movement in July was cut down and at present, the situation in the Far East is not favorable. Goods of Chinese origin have advanced in price with shipments uncertain.

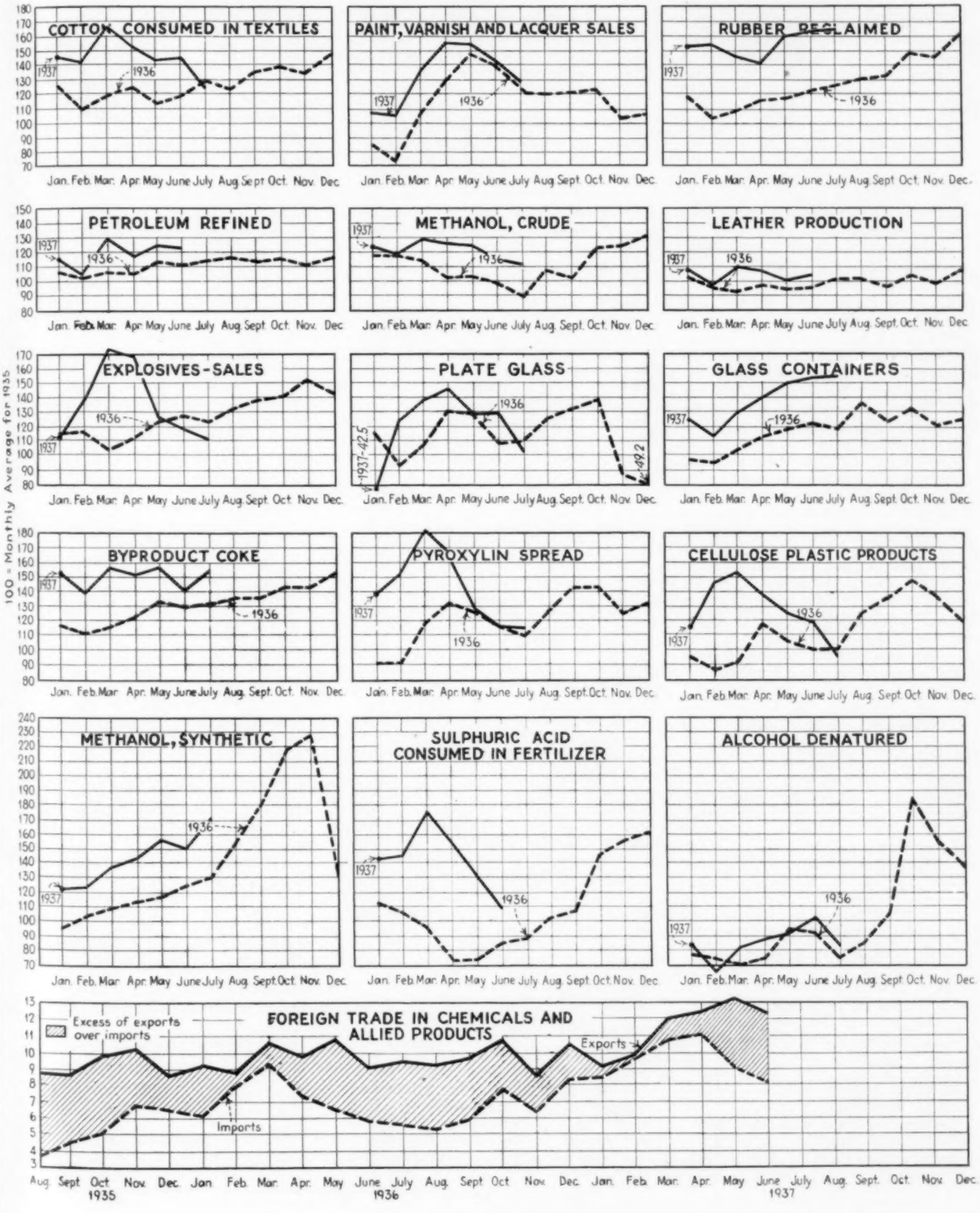
Difficulty in getting shipments through to Chinese industrial centers already has affected export trade with that country. In 1936, China's imports of chemicals were supplied, almost 40 per cent by Germany, 16 per cent by Japan, 12 per cent by the United States, and 12 per cent by Great Britain.

**Production and Consumption Data for Chemical-Consuming Industries**

| | July, 1937 | July, 1936 | Jan.-July, 1937 | Jan.-July, 1935 | Gain for 1937 per cent |
|---|---|---|---|---|---|
| **PRODUCTION** | | | | | |
| Alcohol, denatured, 1,000 wi. gal | 6,753 | 6,122 | 48,454 | 45,097 | 7.4 |
| *Ammonia, tons | 69,204 | 58,238 | 480,171 | 379,952 | 26.4 |
| Automobiles, number | 438,834 | 440,731 | 3,227,683 | 2,929,291 | 10.2 |
| Benzol, 1,000 gal | 10,762 | 8,869 | 71,683 | 59,961 | 19.5 |
| Byproduct coke, 1,000 tons | 4,422 | 3,723 | 30,118 | 24,375 | 23.6 |
| Cellulose acetate plastics, 1,000 lb | 831 | 1,002 | 8,269 | 6,516 | 26.9 |
| Nitrocellulose plastics, 1,000 lb | 1,281 | 1,225 | 11,621 | 8,887 | 30.8 |
| Glass containers, 1,000 gr | 4,978 | 3,844 | 31,471 | 24,656 | 27.6 |
| Plate glass, 1,000 sq. ft | 15,345 | 16,428 | 121,922 | 118,509 | 2.9 |
| Methanol, crude, 1,000 gal | 465 | 385 | 3,578 | 3,117 | 14.8 |
| Methanol, synthetic, 1,000 gal | 2,565 | 1,951 | 15,078 | 11,853 | 27.2 |
| Pyroxylin spread, 1,000 lb | 4,317 | 4,668 | 42,252 | 33,652 | 25.6 |
| Rosin, wood, bbl | 65,561 | 55,151 | 432,765 | 371,593 | 16.5 |
| Turpentine, wood, bbl | 10,022 | 8,523 | 67,240 | 60,276 | 11.5 |
| Rubber reclaimed, tons | 16,241 | 11,628 | 106,753 | 78,343 | 36.3 |
| Steel barrels and drums, number | 716,038 | 759,275 | 6,026,916 | 4,653,525 | 29.5 |
| **CONSUMPTION** | | | | | |
| Cotton, 1,000 bales | 583 | 607 | 4,773 | 3,927 | 21.5 |
| Silk, bales | 31,399 | 36,658 | 265,627 | 241,794 | 9.8 |
| Explosives, sales, 1,000 lb | 27,291 | 30,484 | 217,618 | 177,430 | 22.7 |
| Rubber, crude, tons | 43,560 | 48,250 | 355,657 | 331,950 | 7.1 |

* Sulphate equivalent of byproduct coke oven production.

# TRENDS OF PRODUCTION AND CONSUMPTION



# IMPROVED CALL REPORTED FOR VARIOUS CHEMICAL PRODUCTS

SOME improvement was reported in demand for chemicals in the latter part of August and in the present month to date. Call for white lead was stimulated late in August by an announcement that an advance of one-half cent per lb. would become effective on Sept. 1. Higher prices for the metal were responsible for the rise in the pigment schedule and corroders were not willing early in the month to accept business at the quoted figure for delivery beyond the current month.

Contract deliveries of mineral acids, alkalis, and chlorine are reported to be going forward with regularity and in some sections stocks of sulphuric acid are still small with a very firm tone to prices.

Despite the fact that some consuming industries operated less actively during the hot-weather period, prices for chemicals have been well maintained and the weighted index number for last month again turned upward with higher prices in effect for such chemicals as metal salts, phenol, and cream of tartar. The schedule of prices for denatured alcohol —anti-freeze grade—also announced during the month and is higher than the figure at which last year's supply was sold. Other grades of industrial alcohol were not changed in price. A revised method for quoting on cobalt metal has been adopted with metal refined in Belgium varying from $1.36 per lb. to $1.92 per lb., according to quantity. Cobalt oxide is still held at $1.67 per lb.

Prices for vegetable oils as recorded by the weighted index number were decidedly lower for the period. Price changes within the group, however, were in both directions as some imported oils were commanding higher prices with the majority of domestic oils below the levels last reported. Incidentally trading in linseed oil futures which opened on Sept. 1 has not yet attracted much attention from crushers as a hedging market.

In the market for naval stores, both rosin and turpentine have held an easy price position from the time that new crop offerings came on the market. Export demand in the first half of this year was considerably below that for the like period of last year with a drop of more than 21 per cent in the case of gum rosin and of nearly 16 per cent in the case of gum turpentine. The two marketing organizations formed by producers are expected to keep the market from undue selling pressure and their influence will be followed with interest as the season progresses.

Reports from abroad indicate that supplies of phenol are limited and this is in line with statements that export inquiry has increased of late. As there has been a good call from domestic buyers, the home output is finding a ready market and producers have marked up the price.

Exports of casein from the Argentine declined to 9,465 metric tons in the first half of 1937 from 10,288 tons in the same months of last year, according to reports from Buenos Aires. Exports to Germany, the largest purchaser, declined from 5.913 to 2.591 tons but shipments to the United Kingdom increased from 1,148 to 1,656 tons and those to the United States from 1,169 to 1,203 metric tons.

The borax cartel of Czechoslovakia which was to expire on June 30, 1937, has been extended for another year, according to advices from Prague. The Czechoslovakian organization is a member of the international borax cartel, it is stated.

The German firm which has been manufacturing the fertilizer known as "Hakaphos," has discontinued the line and replaced it with "Hakaphos-Neu" which is said to be a complete plant food. It is sold in 5 kilo tins, and in 10 and 25 kilo buckets and pails chiefly to gardeners and horticulturists. Exportation of this product has been prohibited, according to reports from Berlin.

Regulations governing the inspection, sampling and quality certification of cottonseed have been fixed by the Department of Agriculture. Thus there is initiated an important new cottonseed marketing supervision, which is expected ultimately to extend to rather full regulation of the seed and seed-crushing industry.

A few modifications in the 1932 official standards for grades of cottonseed have been made; and new rules regarding sampling and testing are announced. It is expected that those making analyses of cottonseed for the public will be fully supervised under licenses and standard test procedures enforced.

The objective of this regulatory effort is primarily protection of cotton growers and ginners against the fraud that may result from under-rating the quality of the seed supplied. But it is expected that dependable inspection service and wider use of uniform standards of quality will be equally beneficial to refiners and users of cottonseed oil.

Consequent upon the flareup of war in the Orient, drug and chemical values have been climbing steadily in this country, with a marked slackening of offerings, which, in some cases, has mounted to complete stoppage of shipments.

China wood oil has been quoted at high levels and American importers are inclined to believe that even if the hostilities in China are of short duration, effects of the situation will be prolonged since the amount of destruction of oil stocks and the disruption of production can not be known for some time.

Perilla oil also has increased in price since the outbreak of the hostilities. Much of the advance is credited to purchase of perilla as a substitute for wood oil.

Among chemical developments in foreign countries, it is reported to the Department of Commerce that until recently Japan had only one plant for the production of carbon black but others are now being established in Formosa for the extraction of this material from natural gas. Production of carbon black from all plants is expected to aggregate 3,350 metric tons during the current year which is more than half the estimated annual consumption of from 5,000 to 6,000 metric tons.

Italian alcohol production more than doubled last year reaching a total of 29,000,000 gal. against an output recorded at 13,680,000 gal. in 1935, according to reports from Rome. Less grain was used in the manufacture of alcohol during the latter year but distillation from sugar byproducts almost tripled, and sugar was used for the first time.

The Japanese Government—as well as the trade—is working on estimates for consumption of ammonium sulphate for the next fiscal year (August 1937-July 1938). With an anticipated increase of 10 to 15 per cent in consumption, imports of 100,000 tons will be necessary.

## CHEM. & MET. Weighted Index of CHEMICAL PRICES

Base=100 for 1927

| | |
|---|---|
| **This month** | 90.48 |
| Last month | 90.00 |
| September, 1936 | 86.34 |
| September, 1935 | 87.35 |

Higher prices for metal salts, particularly lead carbonate had a bullish effect on the weighted index number. Heavy chemicals, as a rule held a steady price course. Turpentine sold at lower levels.

## CHEM. & MET. Weighted Index of Prices for OILS AND FATS

Base=100 for 1927

| | |
|---|---|
| **This month** | 88.80 |
| Last month | 92.77 |
| August, 1936 | 90.92 |
| August, 1935 | 85.10 |

Oriental oils were sharply higher in price with China wood in a nominal position as far as futures were concerned. Domestic oils and fats were reduced with new crop crude cottonseed oil leading in the decline.

# Current PRICES

## INDUSTRIAL CHEMICALS

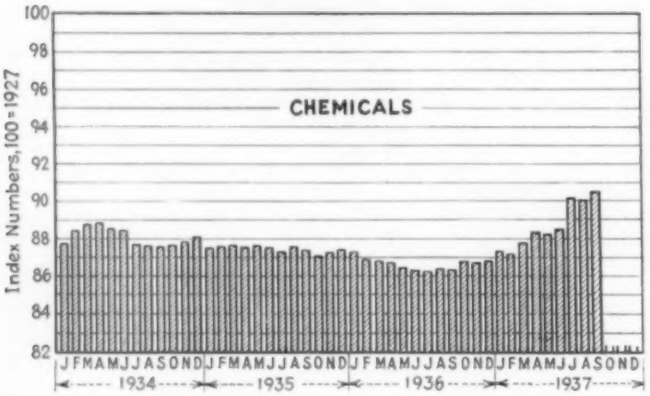
| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Acetone, drums, lb. | $0.06 –$0.07 | $0.06 –$0.07 | $0.08 –$0.09 |
| Acid, acetic, 28%, bbl., cwt. | 2.53 – 2.78 | 2.53 – 2.78 | 2.45 – 2.70 |
| Glacial 99%, drums | 8.70 – 8.95 | 8.70 – 8.95 | 8.43 – 8.68 |
| U. S. P. reagent | 10.75 –11.00 | 10.75 –11.00 | 10.52 –10.77 |
| Boric, bbl., ton | 105.00–115.00 | 105.00–115.00 | 105.00–115.00 |
| Citric, kegs, lb. | .25 – .28 | .25 – .28 | .26 – .29 |
| Formic, bbl., ton | .11 – .11½ | .11 – .11½ | .11 – .11½ |
| Gallic, tech., bbl., lb | .60 – .65 | .60 – .65 | .60 – .65 |
| Hydrofluoric 30% carb., lb. | .07 – .07½ | .07 – .07½ | .07 – .07½ |
| Lactic, 44%, tech., light, bbl., lb. | .06½– .06¾ | .06½– .06¾ | .11½– .12 |
| Muriatic, 18°, tanks, cwt. | 1.05 –..... | 1.05 –..... | 1.00 – 1.10 |
| Nitric, 36°, carboys, lb. | .05 – .05½ | .05 – .05½ | .05 – .05½ |
| Oleum, tanks, wks., ton | 18.50 –20.00 | 18.50 –..... | 18.50 –20.00 |
| Oxalic, crystals, bbl., lb. | .10¾– .12 | .10¾– .12 | .11¾– .12½ |
| Phosphoric, tech., c'bys., lb. | .09 – .10 | .09 – .10 | .09 – .10 |
| Sulphuric, 60°, tanks, ton | 13.00 –..... | 13.00 –..... | 11.00 –11.50 |
| Sulphuric, 66°, tanks, ton | 16.50 –..... | 16.50 –..... | 15.50 –..... |
| Tannic, tech., bbl., lb. | .26 – .30 | .26 – .30 | .20 – .30 |
| Tartaric, powd., bbl., lb. | .24½– .25¼ | .24½– .25¼ | .24 – .25 |
| Tungstic, bbl., lb. | 2.75 –..... | 2.75 –..... | 2.50 – 2.75 |
| Alcohol, Amyl | –..... | –..... | –..... |
| From Pentane, tanks, lb. | .123–..... | .123–..... | .143–..... |
| Alcohol, Butyl, tanks, lb. | .08½–..... | .08¾–..... | .08¾–..... |
| Alcohol, Ethyl, 190p'f., bbl., gal. | 4.14 –..... | 4.14 –..... | 4.27½–..... |
| Denatured, 190 proof | | | |
| No. 1 special, dr., gal wks. | .34 –..... | .34 –..... | .29 –..... |
| Alum, ammonia, lump, bbl., lb. | .03 – .04 | .03 – .04 | .03 – .04 |
| Potash, lump, bbl., lb. | .03½– .04 | .03½– .04 | .03 – .04 |
| Aluminum sulphate, com bags cwt. | 1.35 – 1.50 | 1.35 – 1.50 | 1.35 – 1.50 |
| Iron free, bg., cwt | 2.00 – 2.25 | 2.00 – 2.25 | 2.00 – 2.25 |
| Aqua ammonia, 26°, drums, lb. | .02½– .03 | .02½– .03 | .02½– .03 |
| tanks, lb. | .02½– .02¾ | .02½– .02¾ | .02¼– .02½ |
| Ammonia, anhydrous, cyl., lb. | .16 –..... | .....– .16 | .15½– .16 |
| tanks, lb. | .04¼–..... | .04¼–..... | .04¼–..... |
| Ammonium carbonate, powd tech., casks, lb. | .08 – .12 | .08 – .12 | .08 – .12 |
| Sulphate, wks., cwt. | 1.425–..... | 1.425–..... | 1.25 –..... |
| Amylacetate tech., tanks, lb. | .11½– .12 | .11½– .12 | .12 –..... |
| Antimony Oxide, bbl., lb. | .15½– .16 | .15½– .16 | .12½– .13 |
| Arsenic, white, powd., bbl., lb. | .03 – .03¼ | .03 – .03¼ | .03¼– .04 |
| Red, powd., kegs, lb. | .15½– .16 | .15½– .16 | .15½– .16 |
| Barium carbonate, bbl., ton | 52.50 –57.50 | 52.50 –57.50 | 56.50 –58.00 |
| Chloride, bbl., ton | 72.00 –74.00 | 72.00 –74.00 | 72.00 –74.00 |
| Nitrate, cask, lb. | .07 – .08 | .07 – .08 | .08¼– .09 |
| Blanc fixe, dry, bbl., lb. | .03½– .04 | .03½– .04 | .03½– .04 |
| Bleaching powder, f. o. b., wks., drums, cwt. | 2.00 – 2.10 | 2.00 – 2.10 | 2.00 – 2.10 |
| Borax, gran., bags, ton | 46.00 –51.00 | 46.00 –51.00 | 44.00 –49.00 |
| Bromine, cs., lb. | .36 – .38 | .36 – .38 | .36 – .38 |
| Calcium acetate, bags | 2.25 –..... | 2.25 –..... | 2.10 –..... |
| Arsenate, dr., lb. | .06½– .07 | .06½– .07 | .06 – .07 |
| Carbide drums, lb. | .05 – .06 | .05 – .06 | .05 – .06 |
| Chloride, fused, dr., del., ton | 20.00 –33.00 | 20.00 –33.00 | 20.00 –33.00 |
| flake, dr., del., ton | 22.00 –35.00 | 22.00 –35.00 | 22.00 –35.00 |
| Phosphate, bbl., lb. | .07½– .08 | .07½– .08 | .07½– .08 |
| Carbon bisulphide, drums, lb. | .05 – .06 | .05 – .06 | .05½– .06 |
| Tetrachloride drums, lb. | .05½– .08¾ | .05½– .06 | .05½– .06 |
| Chlorine, liquid, tanks, wks., lb. | 2.15 –..... | 2.15 –..... | 2.15 –..... |
| Cylinders | .05½– .06 | .05½– .06 | .05½– .06 |
| Cobalt oxide, cans, lb. | 1.67 – 1.70 | 1.67 – 1.70 | 1.41 – 1.51 |
| Copperas, bgs., f.o.b., wks., ton | 15.00 –16.00 | 15.00 –16.00 | 15.00 –16.00 |
| Copper carbonate, bbl., lb. | 10¾– .19¼ | .10¾– .19 | .11½– .16 |
| Sulphate, bbl., cwt. | 5.15– 5.40 | 5.15 – 5.40 | 4.00 – 4.25 |
| Cream of tartar, bbl., lb. | .19½– .20 | .18½– .19 | .16½– .17 |
| Diethylene glycol, dr., lb. | .22 – .23 | .22 – .23 | .16½– .20½ |
| Epsom salt, dom., tech., bbl., cwt. | 1.80 – 2.00 | 1.80 – 2.00 | 1.80– 2.00 |
| Ethyl acetate, drums, lb. | .07½–..... | .07¼–..... | .07 –..... |
| Formaldehyde, 40%, bbl., lb. | .05½– .06½ | .05½– .06½ | .06 – .07 |
| Furfural, dr., lb. | .10 – .17½ | .10 – .17½ | .10 – .17½ |
| Fusel oil, ref. drums, lb. | .16 – .18 | .16 – .18 | .16 – .18 |
| Glaubers salt, bags, cwt. | .95 – 1.00 | .95 – 1.00 | .85 – 1.00 |
| Glycerine, c.p., drums, extra, lb. | .23½–..... | .23½–..... | .19½–..... |
| Lead: | | | |
| White, basic carbonate, dry casks, lb. | .08 –..... | .07½–..... | .06½–..... |
| White, basic sulphate, sck., lb. | .07½–..... | .07½–..... | .06 –..... |
| Red, dry, sck, lb. | .09 –..... | .09 –..... | .07 –..... |
| Lead acetate, white crys., bbl., lb. | .13½– .14 | .13½– .14 | .10½– .11 |
| Lead arsenate, powd., bbl., lb. | .11½– .12 | .11½– .12 | .09 – .10 |
| Lime, chem., bulk, ton | 8.50 –..... | 8.50 –..... | 8.50 –..... |
| Litharge, pwd., csk., lb. | .08 –..... | .08 –..... | .06 –..... |
| Lithophone, bags, lb. | .04½– .04¾ | .04½– .04¾ | .04½– .05 |
| Magnesium carb., tech., bags, lb. | .06 – .06½ | .06 – .06½ | .06 – .06½ |
| Methanol, 95%, tanks, gal. | .31 –..... | .31 –..... | .33 –..... |
| 97%, tanks, gal. | .32 –..... | .32 –..... | .34 –..... |
| Synthetic, tanks, gal. | .33 –..... | .33 –..... | .35½–..... |
| Nickel salt, double, bbl., lb. | .13 – .13½ | .13 – .13½ | .13 – .13½ |
| Orange mineral, csk., lb. | .12 –..... | .12 –..... | .10 –..... |
| Phosphorus, red, cases, lb. | .40 – .42 | .40 – .42 | .44 – .45 |
| Yellow, cases, lb. | .24 – .30 | .24 – .30 | .28 – .32 |
| Potassium bichromate, casks, lb. | .08½– .09 | .08½– .09 | .08½– .09 |
| Carbonate, 80–85%, calc. csk., lb. | .06½–..... | .06½–..... | .07 – .07½ |
| Chlorate, powd., lb. | .09½–..... | .09½– .09 | .08 – .08½ |
| Hydroxide (c'stic potash) dr., lb. | .07 – .07½ | .07 – .07½ | .06½– .06½ |
| Muriate, 80% bgs., ton | 23.00 –..... | 23.00 –..... | 22.00 –..... |
| Nitrate, bbl. lb. | .05½– .06 | .05½– .06 | .05½– .06 |
| Permanganate, drums, lb. | .18½– .19 | .18½– .19 | .18½– .19 |
| Prussiate, yellow, casks, lb. | .15 – .16 | .15 – .16 | .18 – .19 |
| Sal ammoniac, white, casks, lb. | .05 – .05½ | .05 – .05½ | .04½– .05 |
| Salsoda, bbl., cwt. | 1.00 – 1.05 | 1.00 – 1.05 | 1.00 – 1.05 |
| Salt cake, bulk, ton | 13.00 –15.00 | 13.00 –15.00 | 13.00 –15.00 |
| Soda ash, light, 58%, bags, contract, cwt. | 1.23 –..... | 1.23 –..... | 1.23 –..... |
| Dense, bags, cwt. | 1.25 –..... | 1.25 –..... | 1.25 –..... |
| Soda, caustic, 76%, solid, drums, contract, cwt. | 2.60 – 3.00 | 2.60 – 3.00 | 2.60 – 3.00 |
| Acetate, works, bbl., lb. | .04½– .05 | .04½– .05 | .04½– .05 |
| Bicarbonate, bbl., cwt. | 1.75 – 2.00 | 1.75 – 2.00 | 1.85 – 2.00 |
| Bichromate, casks, lb. | .06½– .07 | .06½– .07 | .06½– .07 |
| Bisulphate, bulk, ton | 15.00 –16.00 | 15.00 –16.00 | 15.00 –16.00 |
| Bisulphite, bbl., lb. | .03½– .04 | .03½– .04 | .03 – .04 |
| Chlorate, kegs, lb. | .06½– .06¾ | .06½– .06¾ | .06½– .06¾ |
| Chloride, tech., ton | 12.00 –14.75 | 12.00 –14.75 | 12.00 –14.75 |
| Cyanide, cases, dom., lb. | .16½– .17 | .16½– .17 | .15½– .16 |
| Fluoride, bbl., lb. | .07½– .08 | .07½– .08 | .07½– .08 |
| Hyposulphite, bbl., cwt. | 2.40 – 2.50 | 2.40 – 2.50 | 2.40 – 2.50 |
| Metasilicate, bbl., cwt. | 2.15 – 3.15 | 2.15 – 3.15 | 2.90 – 3.00 |
| Nitrate, bags, cwt. | 1.45 –..... | 1.45 –..... | 1.29 –..... |
| Nitrite, casks, lb. | .07 – .08 | .07 – .08 | .07½– .08 |
| Phosphate, dibasic, bbl., lb. | 1.70 –..... | 1.70 –..... | .022– .024 |
| Prussiate, yel. drums, lb. | .10 – .11 | .10– .11 | .11½– .12 |
| Silicate (40° dr.) wks., cwt. | .80 – .85 | .80 – .85 | .80 – .85 |
| Sulphide, fused, 60–62%, dr., lb. | .02½– .03¼ | .02½– .03 | .02½– .03 |
| Sulphite, cyrs., bbl., lb. | .02½– .02¾ | .02½– .02¾ | .02½– .02¾ |
| Sulphur, crude at mine, bulk, ton | 18.00 –..... | 18.00 –..... | 18.00– ..... |
| Chloride, dr., lb. | .03 – .04 | .03 – .04 | .03¼– .04 |
| Dioxide, cyl., lb. | .07 – .08 | .06½– .08 | .07 – .07½ |
| Flour, bag, cwt. | 1.60 – 3.00 | 1.60 – 3.00 | 1.60 – 3.00 |
| Tin Oxide, bbl., lb. | .60 –..... | .58 –..... | .47 –..... |
| Crystals, bbl., lb. | .42 –..... | .41½–..... | .34 –..... |
| Zinc, chloride, gran., bbl., lb. | .05 – .06 | .05 – .06 | .05 – .06 |
| Carbonate, bbl., lb. | .14 – .15 | .14 – .15 | .09 – .11 |
| Cyanide, dr., lb. | .36 – .38 | .36 – .38 | .36 – .38 |
| Dust, bbl., lb. | .091–..... | .089–..... | .068–..... |
| Zinc oxide, lead free, bag., lb. | .06½–..... | .06½–..... | .05 –..... |
| 5% lead sulphate, bags, lb. | .06½–..... | .06½–..... | .04½–..... |
| Sulphate, bbl., cwt. | 3.15 – 3.60 | 3.15 – 3.60 | 2.65 – 3.00 |

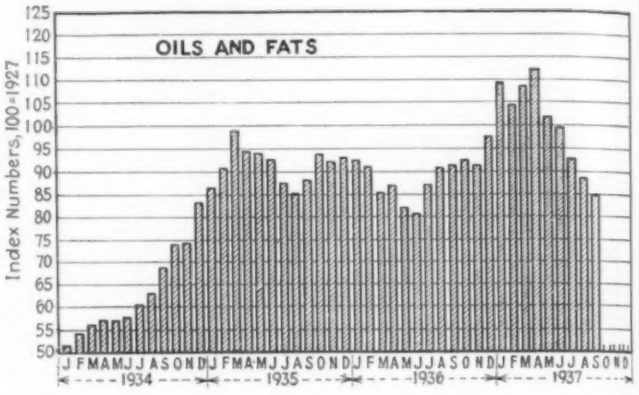
**The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to September 14**

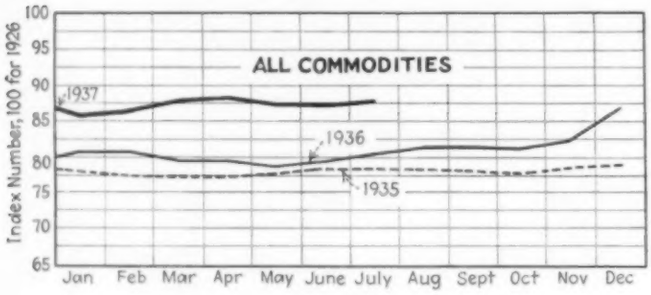
## OILS AND FATS

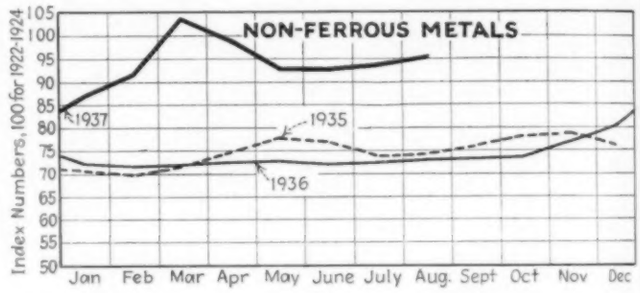
| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Castor oil, No. 3, bbl., lb. | $0.10½–$0.11 | $0.10½–$0.11 | $0.10 –$0.11 |
| Chinawood oil, bbl., lb. | .19 –..... | .12 –..... | .14½–..... |
| Coconut oil, Ceylon, tanks, N. Y. lb. | .04½–..... | .05½–..... | .06 –..... |
| Corn oil crude, tanks (f.o.b. mill), lb. | .07½ ..... | .08 –..... | .09½–..... |
| Cottonseed oil, crude (f.o.b. mill), tanks, lb. | .06½–..... | .07 –..... | .09½–..... |
| Linseed oil, raw car lots, bbl., lb. | .108–..... | .112–..... | .101–..... |
| Palm, casks, lb. | .05 –..... | .05½–..... | .05 –..... |
| Peanut oil, crude, tanks (mill), lb. | .07½–..... | .08 –..... | .09½–..... |
| Rapeseed oil, refined, bbl., gal. | .95 –..... | .96 –..... | .65 –..... |
| Soya bean, tank, lb. | .07½–..... | .07½–..... | .08½–..... |
| Sulphur (olive foots), bbl., lb. | .10½–..... | .11½–..... | .09½–..... |
| Cod, Newfoundland, bbl., gal. | .52 –..... | .52 –..... | .43 –..... |
| Menhaden, light pressed, bbl., lb. | .074–..... | .083–..... | .068–..... |
| Crude, tanks (f.o.b. factory), gal. | .37½–..... | .40 –..... | .30 –..... |
| Grease, yellow, loose, lb. | .06½–..... | .07½–..... | .06½–..... |
| Oleo stearine, lb. | .09 –..... | .09½–..... | .10½–..... |
| Red oil, distilled, d.p. bbl., lb. | .10½–..... | .11½–..... | .09½–..... |
| Tallow extra, loose, lb. | .07½–..... | .07½–..... | .06½–..... |

# CHEM. & MET.'S WEIGHTED PRICE INDEXES




## COAL-TAR PRODUCTS

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Alpha-napthol, crude bbl., lb. | $0.52 –$0.55 | $0.52 –$0.55 | $0.60 –$0.62 |
| Alpha-naphthylamine, bbl., lb. | .32 – .34 | .32 – .34 | .32 – .34 |
| Aniline oil, drums, extra, lb. | .15 – .16 | .15 – .16 | .14½– .15 |
| Aniline salts, bbl., lb. | .22 – .24 | .22 – .24 | .24 – .25 |
| Benzaldehyde, U.S.P., dr., lb. | .85 – .95 | .85 – .95 | 1.10 – 1.25 |
| Benzidine base, bbl., lb. | .70 – .75 | .70 – .75 | .65 – .67 |
| Benzoic acid, U.S.P., kgs., lb. | .52 – .54 | .52 – .54 | .48 – .52 |
| Benzyl chloride, tech., dr., lb. | .25 – .27 | .25 – .27 | .30 – .35 |
| Benzol, 90%, tanks, works, gal. | .16 – .18 | .16 – .18 | .16 – .18 |
| Beta-napthol, tech., drums, lb. | .23 – .24 | .23 – .24 | .24 – .27 |
| Cresol, U.S.P., dr., lb. | .12 – .13 | .12 – .13 | .10 – .11 |
| Cresylic acid, 99%, dr., wks., gal. | .92 – 1.00 | .92 – 1.00 | .73 – .75 |
| Diethylaniline, dr., lb. | .50 – .55 | .50 – .55 | .55 – .58 |
| Dinitrophenol, bbl., lb. | .23 – .25 | .23 – .25 | .29 – .30 |
| Dinitrotoluen, bbl., lb. | .15 – .16 | .15 – .16 | .16 – .17 |
| Dip oil, 25%, dr., gal. | .23 – .25 | .23 – .25 | .23 – .25 |
| Diphenylamine, bbl., lb. | .32 – .36 | .32 – .36 | .38 – .40 |
| H-acid, bbl., lb. | .50 – .55 | .50 – .55 | .65 – .70 |
| Naphthalene, flake, bbl., lb. | .07½– .07¾ | .07½– .07¾ | .07½– .07¾ |
| Nitrobenzene, dr., lb. | .08 – .09 | .08 – .09 | .08½– .10 |
| Para-nitraniline, bbl., lb. | .45 – .47 | .45 – .47 | .51 – .55 |
| Phenol, U.S.P., drums, lb. | .14½– | .13½– .14 | .14½– .15 |
| Picric acid, bbl., lb. | .35 – .40 | .35 – .40 | .30 – .40 |
| Pyridine, dr., gal. | 1.55 – 1.60 | 1.55 – 1.60 | 1.10 – 1.15 |
| Resorcinal, tech., kegs, lb. | .75 – .80 | .75 – .80 | .65 – .70 |
| Salicylic acid, tech., bbl., lb. | .34 – .40 | .34 – .40 | .40 – .42 |
| Solvent naptha, w.w., tanks, gal. | .30 – | .30 – | .26 – |
| Tolidine, bbl., lb. | .88 – .90 | .88 – .90 | .88 – .90 |
| Toluene, tanks, works, gal. | .35 – | .35 – | .30 – |
| Xylene, com, tanks, gal. | .35 – | .35 – | .30 – |

## MISCELLANEOUS

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Barytes, grd., white, bbl., ton. | $22.00–$25.00 | $22.00–$25.00 | $22.00–$25.00 |
| Casein, tech., bbl., lb. | .13 – .14 | .13 – .14 | .17½– .18½ |
| China clay, dom., f.o.b. mine, ton. | 8.00 –20.00 | 8.00 –20.00 | 8.00 –20.00 |
| Dry colors: | | | |
| Carbon gas, black (wks.), lb. | .04 – .20 | .04 – .20 | .04 – .20 |
| Prussian blue, bbl., lb. | .37 – .38 | .37 – .38 | .37 – .38 |
| Ultramarine blue, bbl., lb. | .10 – .26 | .10 – .26 | .10 – .26 |
| Chrome green, bbl., lb. | .21 – .37 | .21 – .37 | .26 – .27 |
| Carmine red, tins, lb. | 4.00 – 4.40 | 4.00 – 4.40 | 4.00 – 4.40 |
| Para toner, lb. | .75 – .80 | .75 – .80 | .80 – .85 |
| Vermilion, English, bbl., lb. | 1.75 – 1.80 | 1.75 – 1.80 | 1.59 – 1.60 |
| Chrome yellow, C. P., bbl., lb. | .14½– .15½ | .14½– .15½ | .12 – .14 |
| Feldspar, No. 1 (f.o.b. N.C.), ton. | 6.50 – 7.50 | 6.50 – 7.50 | 6.50 – 7.50 |
| Graphite, Ceylon, lump, bbl., lb. | .06 – .06½ | .06 – .06½ | .07 – .08½ |
| Gum copal Congo, bags, lb. | .08 – .30 | .08 – .30 | .08 – .30 |
| Manila, bags, lb. | .08½– .14 | .08½– .14 | .09 – .14 |
| Damar, Batavia, cases, lb. | .16 – .24 | .15½– .23 | .15½– .16 |
| Kauri cases, lb. | .18½– .60 | .17½– .60 | .19 – .25 |
| Kieselguhr (f.o.b. N. Y.), ton. | 50.00 –55.00 | 50.00 –55.00 | 50.00 –55.00 |
| Magnesite, calc, ton | 50.00 – | 50.00 – | 50.00 – |
| Pumice stone, lump, bbl., lb. | .05 – .07 | .05 – .08 | .05 – .07 |
| Imported, casks, lb. | .03 – .40 | .03 – .40 | .03 – .35 |
| Rosin, H., bbl. | 9.15 – | 8.85 – | 7.25 – |
| Turpentine, gal. | .35½– | .36 – | .42½– |
| Shellac, orange, fine, bags, lb. | .22 – | .23 – | .25 – |
| Bleached, bonedry, bags, lb. | .17½– | .17½– | .18 – |
| T. N. Bags, lb. | .12½– | .12½– | .14½– |
| Soapstone (f.o.b. Vt.), bags, ton. | 10.00 –12.00 | 10.00 –12.00 | 10.00 –12.00 |
| Talc, 200 mesh (f.o.b. Vt.), ton. | 8.00 – 8.50 | 8.00 – 8.50 | 8.00 – 8.50 |
| 300 mesh (f.o.b. Ga.), ton. | 7.50 –10.00 | 7.50 –10.00 | 7.50 –11.00 |
| 225 mesh (f.o.b. N. Y.), ton. | 13.75 – | 13.75 – | 13.75 – |

## INDUSTRIAL NOTES

ALLEN-BRADLEY CO., Milwaukee, has made Wilson Electrical Equipment Co., Houston, Texas, its representative in the southern territory.

THE TIMKEN ROLLER BEARING CO., Canton, Ohio, has appointed W. P. White, 1208 N. Broad St., Philadelphia, district manager, in charge of steel and tube sales in eastern and southern Pennsylvania.

MATHEWS CONVEYOR CO., Ellwood City, Pa., has opened a sales-engineering office at 2844 West Grand Blvd., Detroit.

D. W. HAERING & CO., INC., Chicago, has appointed Joseph Mallock district manager for Michigan with headquarters in Detroit; B. S. Coop, District manager in the south with headquarters in Atlanta; and Guy Hamilton, district manager for Tennessee, with headquarters in Nashville.

CUTLER-HAMMER, INC., Milwaukee, has opened a new district office at 539 Gravier St., New Orleans, with Joseph Gardberg as manager.

BUFFALO FOUNDRY AND MACHINE CO., Buffalo, has appointed W. C. Grove manager of its office in Chicago.

GENERAL REFRACTORIES CO., Philadelphia, is now represented in the Toledo area by the Hull Industrial Supply Co.

# New CONSTRUCTION

## Where Plants Are Being Built in Process Industries

| | Current Projects | | Cumulative 1937 | |
|---|---|---|---|---|
| | Proposed Work | Contracts | Proposed Work | Contracts |
| New England | $540,000 | $340,000 | $1,485,000 | $2,185,000 |
| Middle Atlantic | 1,830,000 | 1,375,000 | 15,662,000 | 14,346,000 |
| South | 1,300,000 | 1,040,000 | 25,345,000 | 32,443,000 |
| Middle West | 415,000 | 1,860,000 | 12,913,000 | 20,577,000 |
| West of Mississippi | 80,000 | 1,200,000 | 14,252,000 | 8,033,000 |
| Far West | 2,040,000 | 6,340,000 | 5,795,000 | 9,658,000 |
| Canada | 5,040,000 | ..... | 23,805,000 | 1,551,000 |
| Total | $11,245,000 | $12,155,000 | $99,257,000 | $88,793,000 |

## PROPOSED WORK

**Brick Plant**—Brooklyn Inc. Brick Co., Mooresville, Ind., plans rebuilding plant destroyed by fire. Estimated cost including equipment exceeds $40,000.

**Carbon Black Plant**—Stanley Marsh, Jr., Amarillo, Tex., plans to construct a 60 million cu. ft. capacity carbon black plant near Texhoma, Okla. Estimated cost $40,000.

**Chemistry Building and Laboratory**—Miami University, Oxford, O., plans to construct a chemistry building and laboratory. Estimated cost $125,000.

**Factory**—Armstrong Cork Co., Lancaster, Pa. and 1206 Maple Ave., Los Angeles, Calif., plans to construct a factory on a site near South Gate, Calif. Estimated cost $1,000,000.

**Factory**—New Jersey Optical Co., 280 Badger Ave., Newark, N. J., soon lets contract for constructing a factory in Irvington, N. J. Lockwood Greene, 30 Rockefeller Pl., New York, N. Y., Engrs.

**Gas Plant**—City, Jamestown, N. Y., Board Public Utilities, C. O. Johnson, Supt., plans election Nov. 2nd to vote on $1,500,000 bond issue for constructing municipal gas plant and distributing system.

**Gasoline Plant**—Arkansas-Louisiana Gas Co., Ruston, La., plans to construct a gasoline absorption plant. Estimated cost $300,000.

**Gasoline Plant**—Porter Oil Co., Joaquin, Tex., plans to construct a gasoline plant. Estimated cost $40,000 or more.

**Glass Factory**—Carr Lowrey Glass Co., 2201 Kloman St., Baltimore, Md., soon lets contract for constructing addition to present glass factory. Amsler Morton Co., Pittsburgh, Pa., Archts. Estimated cost $100,000.

**Glass Plant**—Duplate Safety Glass Co., Prospect St., Oshawa, Ont., Can., plans to construct an addition to its plant. Allward & Gouinlock, 57 Bloor St. W., Toronto, Ont., Archts.

**Glass Factory**—Forster & Taylor, Engrs., Nicholas Bldg., Toledo, O., will soon award contract for constructing a glass factory for Libby Glass Co., Toledo, O. Estimated cost $250,000.

**Laboratory**—Don Baxter, Inc., 1505 Gardena St., Glendale, Calif., is having plans prepared by E. P. Elden, 106 East Wilson St., Glendale, Calif., Archt., for constructing a laboratory building, warehouse and boiler room an a 2-acre site at Grandview near San Fernando Rd., Glendale, Calif. Estimated cost will exceed $40,000.

**Laboratory**—Brown University, H. M. Wright, Pres., Prospect St., Providence, R. I., soon lets contract for chemical laboratory at Lincoln Field. C. Z. Klauder, 1429 Walnut St., Phila., Pa., Archt. Estimated cost $500,000.

**Oil Processing Factory** — Proctor & Gamble Mfg. Co., 1601 West 7th St., Long Beach, Calif., plans to construct additions to its oil processing buildings. J. H. Davies, Ocean Center Bldg., Long Beach, Calif., Engr. and Archt. Estimated cost $1,000,000.

**Paint Factory**—Intercoastal Paint Co., 2230 Edgewater St., Baltimore, Md., plans rebuilding its factory destroyed by fire. Estimated cost $100,000.

**Plant**—National Gypsum Co., Buffalo, N. Y., plans to construct a plant for manufacture of insulating fibre board in Mobile, Ala. Estimated cost $1,000,000.

**Paint Factory**—McCann Shields Paint Co., 27 Alexander Ave., Pittsburgh, Pa., plans to construct a factory. H. H. Cahoon, 337 Blvd. of the Allies, Pittsburgh, Pa., Archt. Estimated cost $40,000.

**Plant**—G. F. Heublein & Bro., 285-305 Broad St., Hartford, Conn., are having plans prepared by C. J. Malmfeldt, Archt., 15 Lewis St., Hartford, Conn., for constructing addition to plant for distillery, storage and bottling plant. Estimated cost exceeds $40,000.

**Pottery Plant**—Owner, c/o G. P. McKinney, Archt., 927 Fulton Bldg., Pittsburgh, Pa., plans to construct a pottery plant in New Brighton, O. Estimated cost $50,000.

**Sulphite Mill**—Generaimber Co., c/o Marathon Paper Co., Rothschild, Wis., plans to construct a 200-ton sulphite mill in the vicinity of Thunder Bay, Ont., Can. Estimated cost $5,000,000.

## CONTRACTS AWARDED

**Blending Bins**—Universal Atlas Cement Corp., 208 South LaSalle St., Chicago, Ill., has awarded the contract for 8 reinforced-concrete cement-blending bins, to M. A. Long Co., Commonwealth Bldg., Allentown, Pa.

**Chemical Plant**—Davidson Chemical Co., Curtis Bay, Md., has awarded the contract for a plant to include plant for the production of super-phosphate and mixed fertilizers, storage and distribution facilities, to Bartlett-Hayward Co., Koppers Bldg., Pittsburgh, Pa. Estimated cost will exceed $40,000.

**Chemical Plant**—Dewey & Almy Chemical Co., 62 Whittemore Ave., Cambridge, Mass., has awarded the contract for 1 story, 25x45 ft. addition to Building No. 16 and 1 story, 20x100 ft. addition to Building No. 20, to L. C. Blake, 50 Dyer Ave., Wilton, Mass.

**Chemical Plant**—Victor Chemical Works, Chicago, Ill., has awarded the contract for a phosphorus plant at Mount Pleasant, Tenn., to Stone & Webster Engineering Co., 90 Broad St., New York, N. Y. Estimated cost $1,000,000.

**Coke Plant**—Hudson Valley Fuel Corp., 19 2nd St., Troy, N. Y., awarded contract to Koppers Co., Koppers Bldg., Pittsburgh, Pa., to build and purchase material for coke plant. Estimate to exceed $40,000.

**Factory**—Bakelite Corp., 230 Grove St., Bloomfield, N. J., has awarded the contract for a factory at Bound Brook, N. J., to M. Pederson, Perth Amboy, N. J. Estimated cost $40,000 or more.

**Factory**—Doebeckman Co., T. F. Dolan, Pres., 3301 Monroe Ave., Cleveland, O., manufacturer of cellophane, has awarded the contract for an addition to its factory to Bison Co., 12406 Marston St., Cleveland, O. Estimated cost $60,000.

**Factory**—Flintkote Co., Mill St., Lockport, N. Y., has awarded the contract for an addition to its factory on Frost St. to J. O. Ross Engineering Corp., Empire Bldg., Pittsburgh, Pa. Estimated cost $75,000.

**Factory**—General Aniline Works, Grasselli, N. J., has awarded the contract for constructing a manufacturing plant and office building, to White Constr. Co., 95 Madison Ave., New York, N. Y. Estimated cost $500,000.

**Glass Factory**—Corning Glass Works, Corning, N. Y., has awarded the contract for the construction of factory buildings to H. K. Ferguson Co., Euclid Ave., Cleveland, O. Estimated cost will exceed $500,000.

**Glass Factory**—National Glass Co., Trenton, Mich., is awarding separate contracts for the construction of a factory. Estimated cost, $500,000.

**Glass Factory**—Owens Illinois Glass Co., Ohio Bldg., Toledo, O., will construct an addition to its plant at Newark, O. Separate contracts will be awarded. Estimated cost $40,000.

**Laboratory**—Boston Blacking & Chemical Co., Kendall Sq., Cambridge, Mass., has awarded the contract for a 3 and 4 story office and laboratory to Aberthaw Co., 80 Federal St., Boston, Mass. Total estimated cost $300,000.

**Laboratory** — Wander Co., 360 North Michigan Ave., Villa Park, Ill., has awarded the contract for a laboratory to Neff Construction Co., 5654 North Artesian Ave., Chicago, Ill. Estimated cost including equipment $40,000.

**Malt House**—Albert Schwill & Co., 141 West Jackson Bldg., Chicago, Ill., has awarded the contract for constructing malt house to Harvey A. Hanson Co., 1151 Elston St., Chicago, Ill. Estimated cost $350,000.

**Pulp Mill**—Fernandina Pulp & Paper Co., c/o Rainier Pulp & Paper Co., White Bldg., Seattle, Wash., has awarded the contract for constructing its pulp mill to manufacture sulphite pulp which is used in manufacturing rayon, celophane, yarn, staple fiber and other products, to Rust Engineering Co., Clark Bldg., Pittsburgh, Pa. Estimated cost $6,300,000.

**Refinery**—Pure Oil Co., Muskogee, Okla., has awarded the contract for a new cracking plant at the Muskogee refinery to Trans-American Constr. Co., 30 Church St., New York, N. Y. Estimated cost $1,000,000.

**Research Building**—Libbey Owens Ford Glass Co., Toledo, O., has awarded the contract for constructing a technical research building at East Broadway Plant to A. Bentley & Sons, Toledo, O. Estimated cost $450,000.

**Sodium Sulphate Plant**—American Cyanamid Co., 30 Rockefeller Plaza, New York City, N. Y., will construct a sodium sulphite plant at Frost Lake, Lynn Co., O'Donnell, Tex. Work will be done by separate contracts. Estimated cost $200,000.

**Tannery**—Gustav Kittle & Co., 2221 Lister St., Chicago, Ill., has awarded the contract for the construction of a 3 story tannery to Hubschmann Constr. Co., 2220 North Clark St., Chicago, Ill. Estimated cost $40,000.

**Storage**—Alpha Portland Cement Co., Webb Crawford Bldg., Birmingham, Ala., has awarded the contract for constructing an additional reinforced concrete storage bin to McDonald Engineering Co., Chicago, Illinois.

**Warehouse**—Associated Oil Co., Montgomery and Mission Sts., San Francisco, Calif., has awarded the contract for the construction of a warehouse and drum building in Avon, Calif., to Dinwiddie Constr. Co., 210 Crocker Bldg., San Francisco, Calif.

**Warehouse**—Baltimore Pure Rye Distilling Co., Dundalk, Baltimore, Md., has awarded the contract for a warehouse to Engineering Contracting Corp., North and Liman Aves., Baltimore, Md. Estimated cost $100,000.

**Warehouse**—Lady Esther Co., 2012 Ridge Ave., Evanston, Ill., has awarded the contract for constructing a plant, office and warehouse in Clearing Industrial Dist., Chicago, Ill., to Warren B. Ewer Co., 400 West Madison St., Chicago, Ill. Estimated cost $300,000.

**Warehouse** — International Graphite & Electrode Corp., Niagara Falls, N. Y., has awarded the contract for constructing a warehouse to Laur & Mack Constr. Co., Inc., College Ave., Niagara Falls, N. Y.

**Warehouse**—Niagara Alkali Co., 4205 Buffalo Ave., Niagara Falls, N. Y., has awarded the contract for the construction of a warehouse to Scrufari Construction Co., 825 15th St., Niagara Falls, N. Y. Estimated cost $40,000.

**Warehouse**—Hiram Walker, Gooderham & Worts, Peoria, Ill., has awarded the contract for constructing a 150x250 ft. concrete whiskey barrel rack warehouse to V. Jobst & Sons, Peoria, Ill.

# INCREASE IN DENATURED ALCOHOL OUTPUT WIDENS MARKET FOR DENATURANTS

PRODUCTION of ethyl alcohol in the fiscal year ended June 30, 1936 was reported by the Alcohol Tax Unit of the Bureau of Internal Revenue, at 196,126,236 proof gal. which compares with 180,645,920 proof gal. in 1935 and 165,103,582 proof gal. in 1934.

Production of denatured alcohol in 1936 amounted to 101,477,843 wine gal. as compared with 97,031,074 wine gal. in 1935 and 82,241,403 wine gal. in 1934. The trend toward increasing use of specially denatured alcohol continued and withdrawals in 1936 consisted of 64,819,485 wine gal. of specially denatured and 35,700,192 wine gal. of completely denatured, or an increase of 6,166,017 wine gal. for the former and a decrease of 2,350,333 wine gal. for the latter in comparison with withdrawals in the preceding fiscal year.

In the accompanying table will be found estimates of the amounts of the several denaturants consumed at industrial alcohol plants. These estimates were arrived at by multiplying the quantities of denaturants prescribed in the various formulas by the amount of alcohol thus denatured.

Because of the marked drop in production of completely denatured alcohol, formulas No. 5 and No. 5-A, there was a corresponding decrease in the use of the denaturants called for by those formulas. C.D. No. 10, on the other hand, came into greater prominence and called for larger amounts of Tecsol, Pontol, is opropanol, and gasoline. Tecsol held the ranking place with about equal amounts of Pontol and isopropanol being consumed.

In the specially denatured group, vinegar overtops all other denaturants from the standpoint of volume consumed due to the fact that the denaturant makes up one-half of the final denatured product. Use of Formula S.D.-18—in which vinegar is the denaturing material—is on a declining trend and in the first half of the 1937 fiscal year amounted to only 2,828,640 wine gal.

Formula S.D.-1, for which methanol is prescribed as the denaturant is most important because more alcohol is treated under that formula than under any of the other special methods. This affords a good outlet for methanol but fails to compensate for the loss methanol suffered when its market in the completely denatured field was taken away. Incidentally the amount of alcohol denatured as S.D.-1, will show a marked gain for the 1937 fiscal year if the rate established in the first six months is maintained, the six-month total having been 14,826,391 wine gal.

Formula S.D.-2B rates next in importance and is developing an increasingly broad market for benzol as a denaturant.

Formula S.D.-23G, which makes use of acetone and sucrose octa acetate as denaturants is increasing in importance and accounted for 1,904,363 wine gal. of alcohol in the first half of the 1937 fiscal year.

The formulas enumerated in the accompanying table do not include those of minor importance but do account for about 99 per cent of production.

**Alcohol Denaturants: Statistics of Quantities Consumed, 1934-36 (Fiscal Years)**

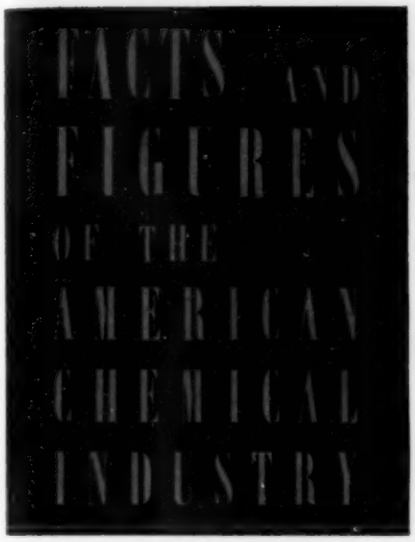
| Formula No. | Denaturants | Requirement per 100 gal. ethyl alcohol | | Ethyl Alcohol Withdrawals — Fiscal Years 1934 | 1935 | 1936 | Denatured Consumption — Fiscal Years 1934 | | 1935 | | 1936 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *(Thousands of wine gallons)* | | | | | | | | |
| C.D. 5 | Isopropanol | 5 | gal. | 12,032 | 4,760 | 300 | 601,600 | gal. | 238,000 | gal. | 15,000 | gal. |
| | Aldehol or denatol, etc. | 0.75 | gal. | ..... | ..... | ..... | 90,240 | gal. | 35,700 | gal. | 2,250 | gal. |
| | Alcotate, etc. | 0.75 | gal. | ..... | ..... | ..... | 90,240 | gal. | 35,700 | gal. | 2,250 | gal. |
| | Alpha terpineol | 0.25 | gal. | ..... | ..... | ..... | 30,080 | gal. | 11,900 | gal. | 750 | gal. |
| 5-A | Isopropanol | 2.5 | gal. | 2,251 | 1,075 | 983 | 56,250 | gal. | 26,875 | gal. | 24,575 | gal. |
| | Pontol | 3 | gal. | ..... | ..... | ..... | 67,530 | gal. | 32,250 | gal. | 29,490 | gal. |
| | Aldehol | 0.5 | gal. | ..... | ..... | ..... | 11,250 | gal. | 5,375 | gal. | 4,915 | gal. |
| | Calorite | 0.5 | gal. | ..... | ..... | ..... | 11,250 | gal. | 5,375 | gal. | 4,915 | gal. |
| | Terpineol | 0.25 | gal. | ..... | ..... | ..... | 5,625 | gal. | 2,688 | gal. | 2,458 | gal. |
| 10 | Tecsol | 5 | gal. | 14,160 | 32,216 | 34,417 | 708,000 | gal. | 1,610,800 | gal. | 1,720,850 | gal. |
| | Pontol | 2.5 | gal. | ..... | ..... | ..... | 354,000 | gal. | 805,400 | gal. | 860,425 | gal. |
| | Isopropanol | 2.5 | gal. | ..... | ..... | ..... | 354,000 | gal. | 805,400 | gal. | 860,425 | gal. |
| | Gasoline | 0.5 | gal. | ..... | ..... | ..... | 70,800 | gal. | 161,080 | gal. | 172,085 | gal. |
| S.D. 1 | Methanol | 5 | gal. | 15,165 | 15,804 | 19,287 | 758,250 | gal. | 790,200 | gal. | 964,350 | gal. |
| 2-B | Benzol | 0.5 | gal. | 13,335 | 15,012 | 16,843 | 66,675 | gal. | 75,060 | gal. | 84,215 | gal. |
| 3-A | Methyl alcohol | 5 | gal. | 687 | 887 | 957 | 34,350 | gal. | 44,350 | gal. | 47,850 | gal. |
| 4 | Nicotine, 40% | 0.05 | gal. | 1,372 | 1,346 | 1,465 | 686 | gal. | 673 | gal. | 733 | gal. |
| | Methylene blue | 0.036 | oz. | ..... | ..... | ..... | 494 | oz. | 485 | oz. | 527 | oz. |
| 12-A | Benzol | 5 | gal. | 200 | 234 | 290 | 10,000 | gal. | 11,720 | gal. | 14,500 | gal. |
| [3] 13-A | Ethyl ether | 10 | gal. | 1,226 | 1,046 | 708 | 122,600 | gal. | 104,600 | gal. | 70,800 | gal. |
| 17 | Animal oil (Dipple's oil) | 0.05 | gal. | 677 | 895 | 937 | 339 | gal. | 498 | gal. | 469 | gal. |
| [2] 18 | Vinegar (not less than 9% acetic acid) | 100 | gal. | 8,032 | 7,434 | 7,137 | 8,032,000 | gal. | 7,434,000 | gal. | 7,137,000 | gal. |
| 19 | Ethyl ether | 100 | gal. | 66 | 84 | 61 | 66,000 | gal. | 84,000 | gal. | 61,000 | gal. |
| 23-A | Acetone U.S.P. | 10 | gal. | 3,728 | 4,220 | 1,496 | 372,800 | gal. | 422,000 | gal. | 149,600 | gal. |
| [1] 23-G | Acetone | 10 | gal. | ..... | 2 | 2,983 | ..... | | 200 | gal. | 298,300 | gal. |
| | Sucrose octa Acetate | 425 | lb. | ..... | ..... | ..... | ..... | | 85 | lb. | 126,778 | lb. |
| 28 | Benzol | 10 | gal. | 352 | 209 | 303 | 35,200 | gal. | 20,900 | gal. | 30,300 | gal. |
| 29 | Acetaldehyde, 100% | 1 | gal. | 3,775 | 5,981 | 5,905 | 37,750 | gal. | 59,810 | gal. | 59,050 | gal. |
| 30 | Methyl alcohol | 10 | gal. | 144 | 129 | 257 | 14,400 | gal. | 12,900 | gal. | 25,700 | gal. |
| 32 | Ethyl ether | 5 | gal. | 266 | 79 | 63 | 13,300 | gal. | 3,950 | gal. | 3,150 | gal. |
| [3] 35-A | Ethyl Acetate U.S.P. | 5 | gal. | 1,331 | 1,343 | 2,187 | 66,550 | gal. | 67,150 | gal. | 109,350 | gal. |
| 37 | Eucalyptol, U.S.P. | 45 | oz. | 629 | 571 | 509 | 283,050 | oz. | 256,950 | oz. | 229,050 | oz. |
| | Thymol, U.S.P. | 30 | oz. | ..... | ..... | ..... | 198,700 | oz. | 171,300 | oz. | 152,700 | oz. |
| | Menthol, U.S.P. | 20 | oz. | ..... | ..... | ..... | 125,800 | oz. | 114,200 | oz. | 101,800 | oz. |
| 38-B | Mixtr. of essential oils, thymol, camphor, menthol, etc. | 10 | lb. | 288 | 282 | 337 | 28,800 | lb. | 28,200 | lb. | 33,700 | lb. |
| [2] 39-B | Diethylphthalate | 2.5 | gal. | 938 | 549 | 290 | 23,450 | gal. | 13,725 | gal. | 7,250 | gal. |
| | Tertiary butyl alcohol | ⅛ | gal. | ..... | ..... | ..... | ..... | | ..... | | 213 | gal. |
| 39-C | Diethylphthalate | 1 | gal. | 204 | 248 | 338 | 2,040 | gal. | 2,480 | gal. | 3,380 | gal. |
| [2] 40 | Brucine sulphate or alkaloid | 3 | oz. | 1,671 | 1,750 | 1,967 | 50,130 | oz. | 52,500 | oz. | 59,010 | oz. |
| | Acetone orisopropanol | 0.5 | gal. | ..... | ..... | ..... | 8,855 | gal. | 8,750 | gal. | 2,527 | gal. |
| | Tertiary butyl alcohol | ⅛ | gal. | ..... | ..... | ..... | ..... | | ..... | | 1,828 | gal. |

Source: Figures — "Statistics on Alcohol" U. S. Treasury Dept., Bur. of Internal Revenue, Alcohol Tax Unit.
Formulas — "Appendix to Regulations No. 3 — Formulae for Completely and Specially Denatured Alcohol" (Revised October, 1931), U. S. Treasury Dept., Bureau of Industrial Alcohol, as amended by Treasury Decisions Nos. 10, 4541, 4553, 4621, 4644 and 4578.

(1) Formula 23-G, which came into use June 1, 1935 (Treasury Decision No. 4541), is the only one permissible for rubbing alcohol. The finished rubbing alcohol must contain small quantities of any 2 of the following: Zinc sulphocarbolate, boric acid, tincture of quassia, and diethyl phthalate.

(2) Formula changed, effective October 1, 1935 (Treasury Decision No. 4578). Proper allowances were made by using monthly statistics.

(3) One of the uses of this formula is the mfr. of the denaturant itself; for the quantities of denaturant so involved, consumption is apparent rather than real.

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FUEL FIRED FURNACE

**1** Phosphorus is found in the form of phosphate rock in the states of Tennessee and Florida. Selected Tennessee deposits are mined and shipped to the nearby Nashville plant of the Victor Chemical Works . . .

**2** . . . where the phosphate rock is smelted in a gigantic fuel-fired furnace by a special process developed by Victor engineers. Electric furnaces also are used for smelting the rock. The elemental phosphorus is released as a gas . . .

**3** After thorough purification this gaseous phosphorus is subsequently oxidized or burned in massive stoves to form phosphorus pentoxide . . .

**4** . . . which in turn is "hydrated" or dissolved in water; then precipitated by electrical precipitators thus producing phosphoric acid of high strength and purity from which a great number of useful products are made.

**5** By combining the purified phosphoric acid, for example, with a calcium compound, mono-calcium phosphate is produced . . . typical of the many important phosphate products of the Victor Chemical Works. For others see opposite page.

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VOLUME 44 NUMBER 9

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S. D. KIRKPATRICK, *Editor*

SEPTEMBER, 1937


# FACTS AND FIGURES OF THE AMERICAN CHEMICAL INDUSTRY

OF ALL PEOPLE, the scientist probably has the most interesting story to tell and yet can't tell it. He is too much absorbed in his work, too specialized in his thoughts,—too busy. So he lets someone else do the talking and, as often as not, the story is so distorted that it is hopelessly misunderstood by the very people it could help.

Chemical industry, too, has a story to tell that is quite different from the sensational accounts of mystery and magic that get into the Sunday supplements. But chemical executives are busy men, guiding a new and rapidly growing industry. Chemists and engineers are more concerned with future developments than with any records of past accomplishments.

Yet there are many people, in all walks of life, who would like to know more about chemical industry. Bankers and investors see chemical advances that affect the value of older securities—perhaps pointing toward a new chemical index of industrial prosperity. The farmer, miner, and forester see new markets developing in chemical industry and wonder what its future holds for them. Railway, waterway and highway bid for the increasing volume of chemical shipments. New chemical plant construction holds the leading place in the building business. Schools and libraries report an unsatisfied demand for data on vocational opportunities in chemical research and plant operation. Legislators and other agents of government seek more accurate knowledge of social and economic trends.

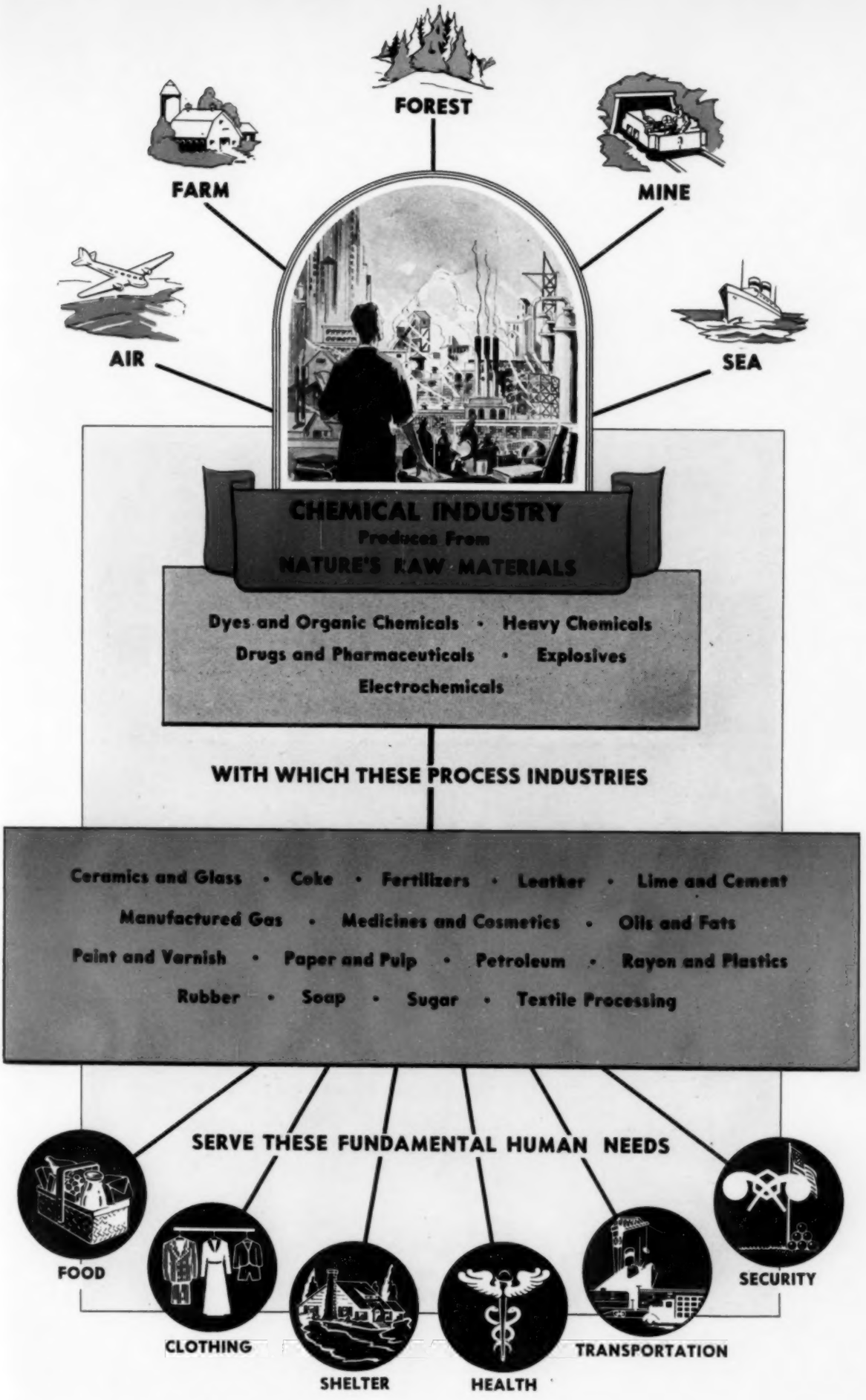
Everywhere the need is for factual information, graphically presented in readily comprehensible terms. Even the industry itself needs to know more about its own operations. So, with the cooperation of well informed leaders of the industry, trade associations and governmental agencies, we have undertaken to bring together for the first time in such a comprehensive presentation—"The Facts and Figures of American Chemical Industry." Its value depends upon its usefulness. If it gives you a better understanding of the work of chemical industry and of its place in the economic and social life of this nation, our humble efforts will have been amply rewarded.

# WHAT IS CHEMICAL INDUSTRY?

BROADLY SPEAKING, chemical industry is a great factory that takes the raw materials of Nature and by means of chemical processes converts them into useful products to serve our human needs. But such a qualitative definition is too broad for our present purposes. We must deal with quantitative facts and figures, being careful not to confuse three different groups of industries—all of which the layman might loosely class as "chemical."

First, and of basic importance, is the strictly chemical industry that makes heavy chemicals such as acids and alkalies, fine chemicals like drugs and dyes, and a host of organic and inorganic products. In the Bureau of Census, this is industry No. 608 and is listed under the unimpressive title: "Chemicals, Not Elsewhere Classified." Furthermore, in Census parlance, "Chemicals, n.e.c." is but a part of a much larger Group VI: "Chemicals and Allied Products." In this group are thirty-one different industries including such major fields as paint and varnish, perfumes and cosmetics, salt, soap and tanning materials.

More useful in our considerations here, however, is the still more comprehensive "Chemical Process Industries" or, simply, "Process Industries." This includes all of the industries that utilize chemical processes and chemical engineering methods. So to "Chemicals and Allied Products," we must add pulp and paper, petroleum refining, rubber, stone, clay and glass—eventually arriving at a group representing almost one-fifth of all the manufacturing enterprise in the United States.


FOREST
FARM
MINE
AIR
SEA
CHEMICAL INDUSTRY
Produces From
NATURE'S RAW MATERIALS
Dyes and Organic Chemicals • Heavy Chemicals
Drugs and Pharmaceuticals • Explosives
Electrochemicals
WITH WHICH THESE PROCESS INDUSTRIES
Ceramics and Glass • Coke • Fertilizers • Leather • Lime and Cement
Manufactured Gas • Medicines and Cosmetics • Oils and Fats
Paint and Varnish • Paper and Pulp • Petroleum • Rayon and Plastics
Rubber • Soap • Sugar • Textile Processing
SERVE THESE FUNDAMENTAL HUMAN NEEDS
FOOD
CLOTHING
SHELTER
HEALTH
TRANSPORTATION
SECURITY

## BASIC DATA FOR CHEMICAL INDUSTRY IN 1935, SUMMARIZED BY STATES

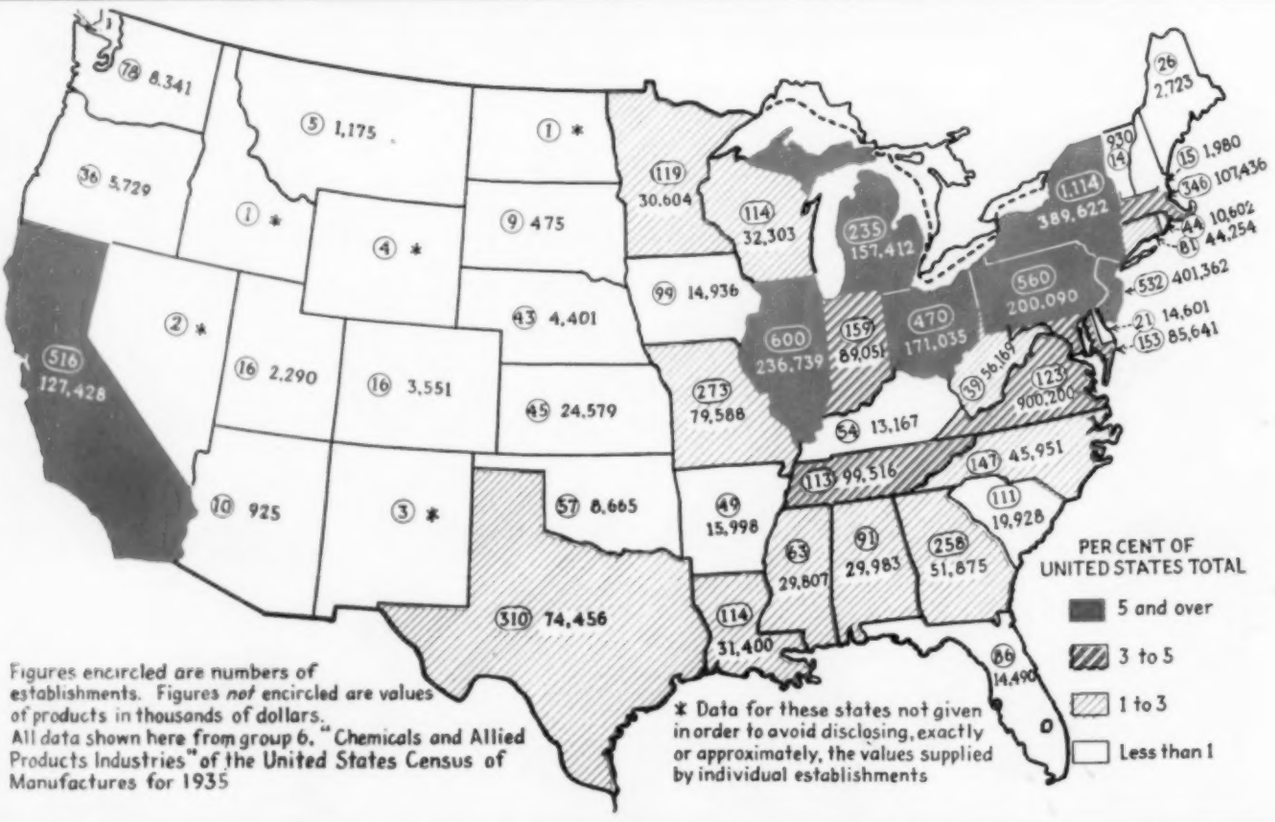
SOURCE: U. S. CENSUS OF MANUFACTURES GROUP 608, "CHEMICALS, N. E. C."

| | Number of establishments | Salaried officers and employees [1] | Wage earners (average for the year) | Salaries [1] | Wages | Cost of materials, containers, fuel, and purchased energy | Value of products | Value added by manufacture |
|---|---|---|---|---|---|---|---|---|
| United States | 570 | 14,541 | 65,838 | $36,591,754 | $80,480,605 | $329,350,435 | $668,697,448 | $339,347,013 |
| Alabama | 4 | 90 | 783 | $275,898 | $685,139 | $3,265,919 | $6,096,359 | $2,830,440 |
| California | 52 | 791 | 3,150 | 1,883,094 | 4,083,770 | 10,733,562 | 27,664,660 | 16,931,098 |
| Colorado | 3 | 5 | 55 | 12,200 | 61,086 | 140,577 | 284,256 | 143,679 |
| Connecticut | 11 | 176 | 673 | 370,766 | 803,016 | 4,294,914 | 6,143,423 | 1,848,509 |
| Illinois | 36 | 646 | 3,648 | 1,468,506 | 4,373,666 | 19,972,124 | 36,394,430 | 16,422,306 |
| Indiana | 11 | 239 | 1,229 | 532,724 | 1,552,655 | 5,657,252 | 10,397,295 | 4,740,043 |
| Iowa | 4 | 45 | 327 | 125,370 | 369,421 | 2,155,380 | 2,869,305 | 713,925 |
| Louisiana | 12 | 134 | 780 | 306,611 | 865,215 | 4,550,050 | 7,324,036 | 2,773,986 |
| Maryland | 12 | 208 | 1,164 | 487,789 | 1,272,268 | 8,052,492 | 11,921,276 | 3,868,784 |
| Massachusetts | 21 | 549 | 2,614 | 1,394,444 | 2,894,805 | 10,773,589 | 20,454,550 | 9,680,961 |
| Michigan | 19 | 1,115 | 5,794 | 2,827,448 | 7,620,048 | 17,520,684 | 45,817,084 | 28,296,400 |
| Minnesota | 6 | 20 | 88 | 36,350 | 84,476 | 756,012 | 1,216,511 | 460,499 |
| New Jersey | 92 | 3,806 | 14,513 | 9,579,998 | 18,198,552 | 67,794,655 | 138,128,726 | 70,334,071 |
| New York | 87 | 2,440 | 9,990 | 6,947,431 | 12,866,833 | 56,750,700 | 123,496,822 | 66,746,122 |
| Ohio | 46 | 805 | 4,715 | 2,424,832 | 6,091,381 | 24,709,740 | 47,474,423 | 22,764,683 |
| Pennsylvania | 55 | 968 | 3,936 | 2,259,128 | 4,460,282 | 31,681,497 | 54,611,444 | 22,929,947 |
| Rhode Island | 6 | 40 | 247 | 104,867 | 293,333 | 1,118,138 | 1,932,132 | 813,994 |
| Tennessee | 10 | 447 | 2,052 | 1,008,545 | 1,936,794 | 10,272,802 | 24,870,886 | 14,598,084 |
| Texas | 8 | 108 | 554 | 234,762 | 556,580 | 1,995,832 | 3,849,071 | 1,853,239 |
| Virginia | 12 | 355 | 2,289 | 899,388 | 2,378,406 | 10,609,738 | 22,429,145 | 11,819,407 |
| Washington | 7 | 44 | 156 | 95,086 | 154,744 | 847,872 | 1,960,315 | 1,112,443 |
| West Virginia | 12 | 804 | 3,473 | 1,746,821 | 4,624,303 | 18,257,292 | 37,292,613 | 19,035,321 |
| Other States [2] | 44 | 646 | 3,608 | 1,569,696 | 4,253,832 | 17,439,614 | 36,068,686 | 18,629,072 |

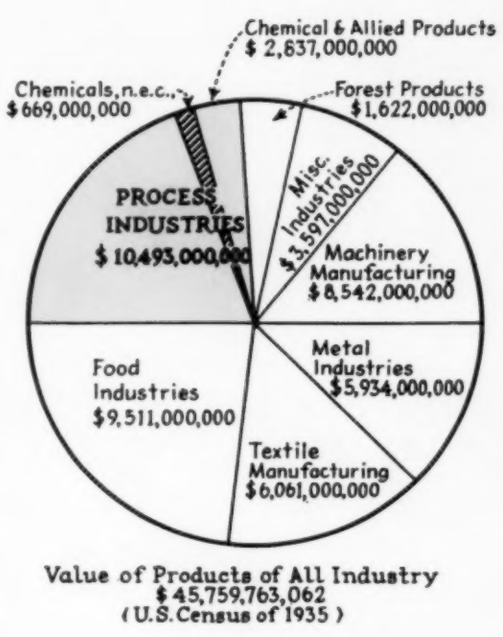
[1] Not including data for employees of central administrative offices.

[2] Arkansas, 2 establishments; Delaware, 1; District of Columbia, 1; Florida, 1; Georgia, 2; Kansas, 2; Kentucky, 2; Maine, 3; Missouri, 8; Montana, 2; New Hampshire, 3; North Carolina, 2; Oklahoma, 2; Oregon, 1; South Carolina, 3; Utah, 2; Wisconsin, 6; Wyoming, 1. Figures combined to avoid disclosing, exactly or approximately, data reported by individual establishments.

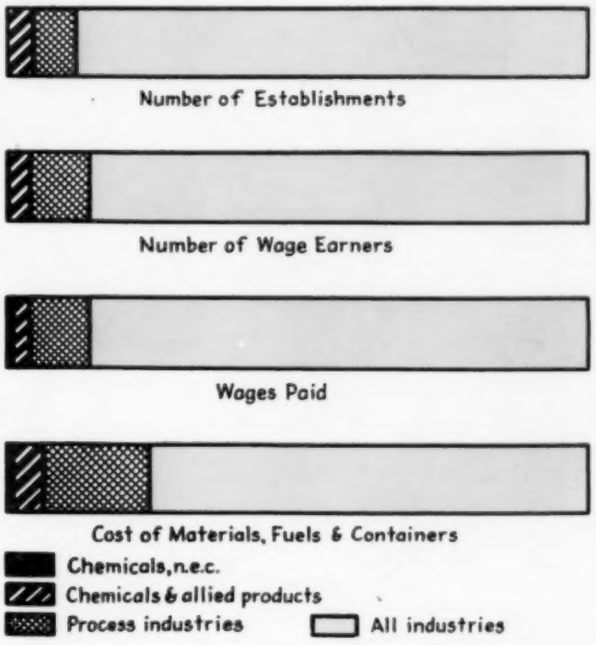
# Plants and Workers in Every State Produce Chemicals and Allied Products



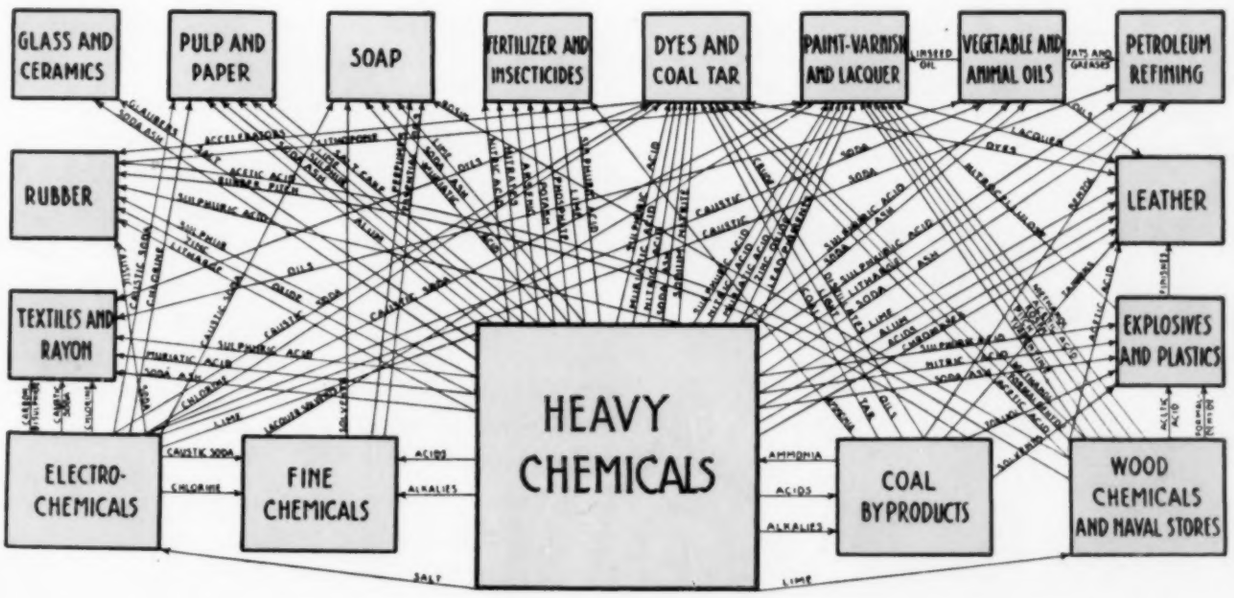
## HOW THE CENSUS CLASSIFIES CHEMICAL AND PROCESS INDUSTRIES




Value of Products of All Industry
$ 45,759,763,062
( U.S. Census of 1935 )




# Heavy Chemicals Underlie Our Industrial Interdependence



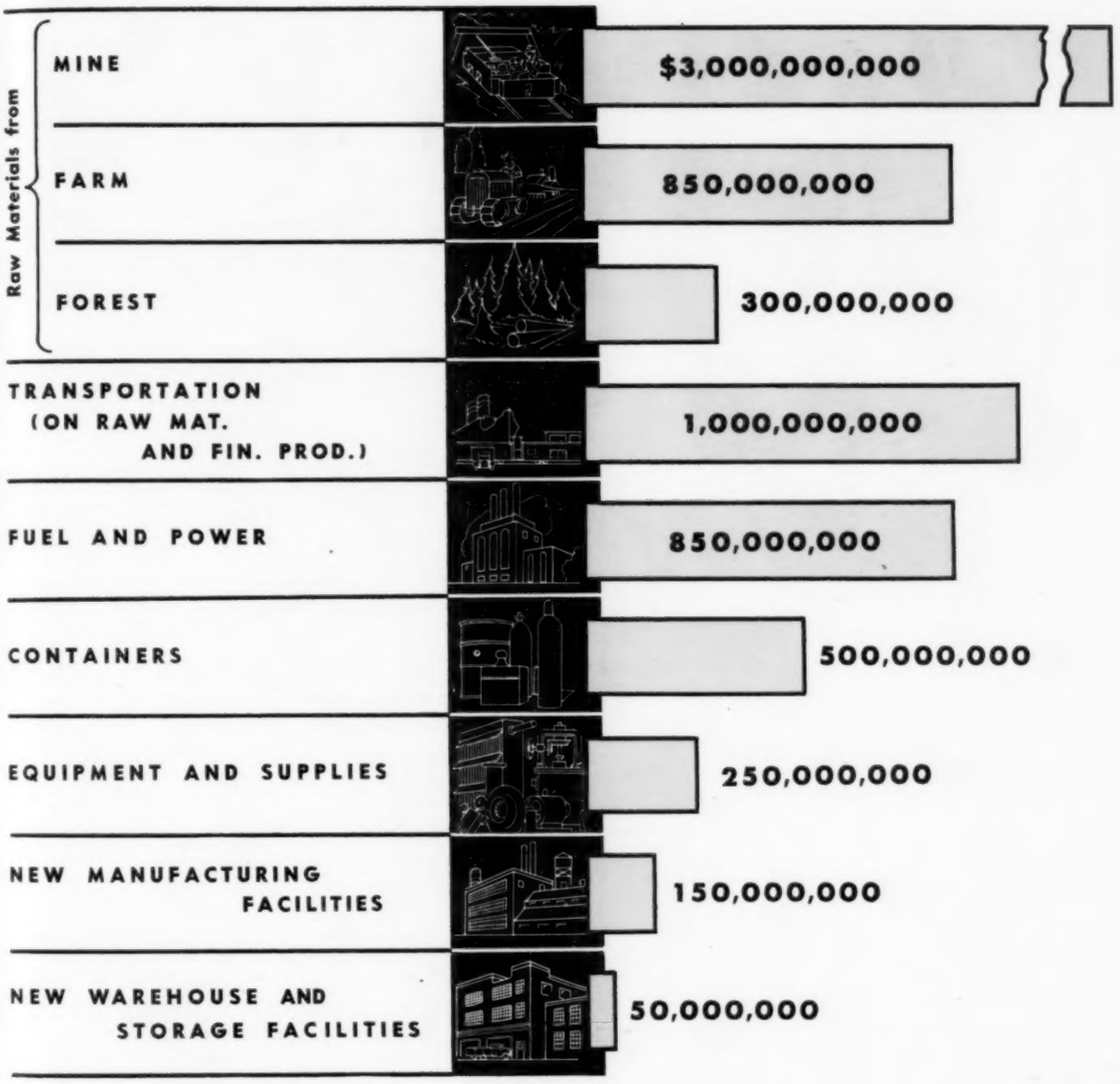
# AMERICAN CHEMICAL INDUSTRY AS A PURCHASER

MINES, FARMS AND FORESTS contribute raw materials that through chemical processing are converted into a variety of more useful commodities of commerce. Sulphur and pyrites yield sulphuric acid for pickling steel or refining petroleum. Coal, salt, limestone, bauxite, potash, phosphate, fluorspar, kaolin, copper, mercury, silver, zinc and lead—are but a few more of many mineral raw materials. From the farmer, chemical process industries buy corn and other grain, cotton and cottonseed, flaxseed, sugarcane and molasses, hides and leather. The forest yields its cellulose from spruce and hemlock for paper pulp, rayon and film, its hardwood for methanol, charcoal and acetic acid, its walnut and chestnut for tanning extracts and its pine stumps for turpentine and rosin. For these raw materials the process industries spend billions of dollars each year as is clearly shown in the pages that follow.

But they are also large buyers of containers—drums, bags and barrels—of tank cars, tankers and transportation facilities, of process equipment, tools and instruments, iron, steel and cement. In 1937 more than $100,000,000 will have been spent for new plant construction and modernization of equipment in process industries. Chemical industry, never built, is always building.

It is well to remember, therefore, that those factors which contribute to the progress and prosperity of the chemical industry are equally important to agriculture, mining and forestry. Continuity of chemical plant operation is as vital to the supplier of raw materials as to the producer of chemicals.

## CHEMICAL PROCESS INDUSTRIES BUY ANNUALLY



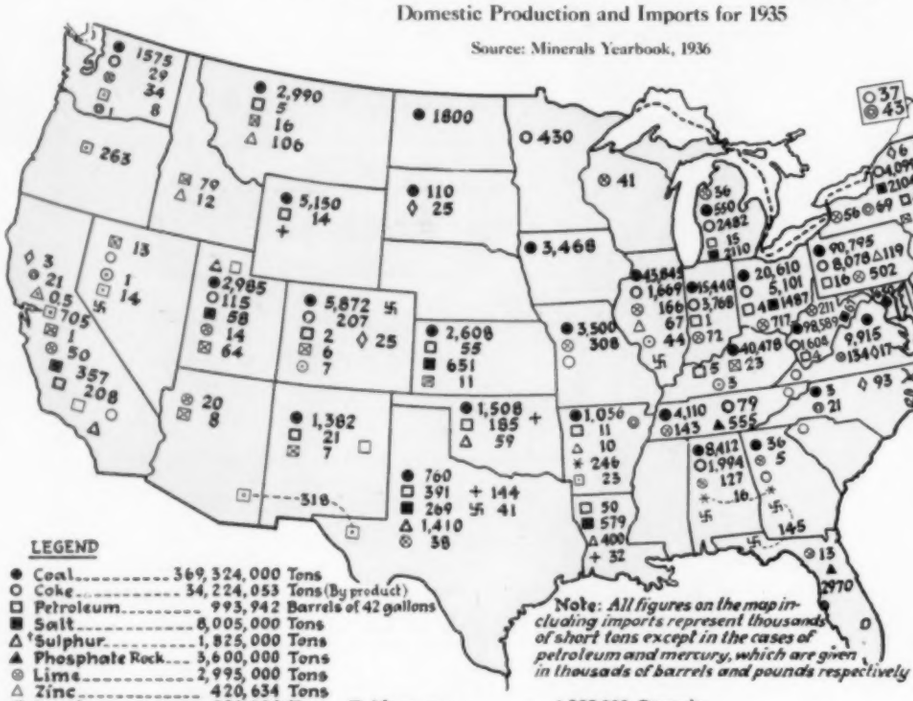

**ESTIMATED EXPENDITURES**
(Other than for Wages & Salaries
Rent, Taxes, Interest, etc.)

# WHERE CHEMICAL INDUSTRIES

## RAW MATERIALS OF MINERAL ORIGIN

Domestic Production and Imports for 1935

Source: Minerals Yearbook, 1936


IMPORTS
Potash 242
Soda Nitrate 281
Barite 46
Fluorspar 16
Chromite 290
Feldspar 10
Asbestos 167
LEGEND
Coal 369,324,000 Tons
Coke 34,224,053 Tons (By product)
Petroleum 993,942 Barrels of 42 gallons
Salt 8,005,000 Tons
†Sulphur 1,825,000 Tons
Phosphate Rock 3,600,000 Tons
Lime 2,995,000 Tons
Zinc 420,634 Tons
Lead 331,720 Tons
†Potash 192,793 Tons
†Barite 218,075 Tons
Bauxite 262,000 Tons
Fluorspar 123,561 Tons
Feldspar 212,500 Tons
Mercury 1,333,000 Pounds
Chromite 920,500 Tons
†Carbon black 176,375,000 Tons
†Fuller's earth 227,745 Tons
Talc and soapstone 172,716 Tons
† In these cases complete information on production by States was lacking
Note: All figures on the map including imports represent thousands of short tons except in the cases of petroleum and mercury, which are given in thousads of barrels and pounds respectively
PRODUCTION OF MINERALS UNDISTRIBUTED
Magnesite 177,154 Tons.
Pyrites 567,000 Tons.
Clay 2,795,924 Tons.
Gypsum 1,937,500 Tons.
Sand 125,690,000 Tons.
Asphalt 3,115,118 Tons.
Sodium Salts 404,903 Tons.
White Arsenic 14,237 Tons.

## SOME MAJOR RAW MATERIALS OF MINERAL ORIGIN

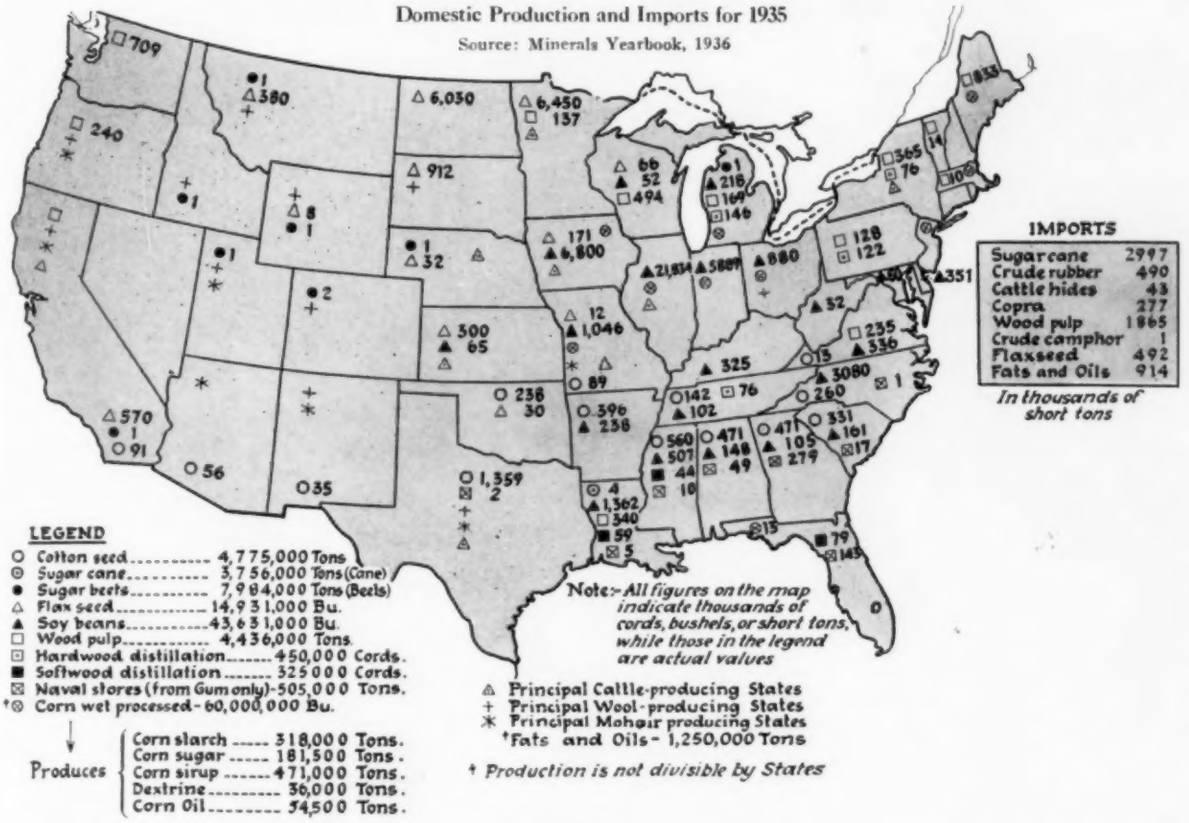
| Material | Uses in Chemical Industry | Quantity Consumed in 1935 |
|---|---|---|
| Aluminum | Aluminum salts | 685 short tons |
| Arsenic, white | Insecticides, weed killers, glass, wood preservative | 26,750 short tons |
| Asphalt | Paints, enamels, japans, lacquers | 20,744 short tons |
| Barytes | Lithopone, barium chemicals | 290,344 short tons |
| Bauxite | Aluminum salts | 145,000 short tons |
| Borax | Glass, ceramics, soap, chemicals, etc | 150,000 short tons |
| Bromine | Bromides, pharmaceuticals, etc | 8,224 short tons |
| Cadmium | Cadmium salts | 204 short tons |
| Calcium Chloride | Chemicals, preservatives, refrigerant, drying agent, etc | 54,000 short tons |
| Chalk | Whiting, putty, paints, rubber pastes, etc | 96,000 short tons |
| Chromite | Chromium salts | 48,000 short tons |
| Clay | Glass, ceramics, etc | 2,828,000 short tons |
| Coal | Coke, gas, cement | 56,675,000 short tons |
| Cobalt | Chemicals, paints, ceramics | 200 short tons |
| Coke | Water gas | 802,206 short tons |
| Copper | Copper salts | 8,000 short tons |
| Feldspar | Glass, ceramics, soap | 199,000 short tons |
| Fluorspar | Glass, enamelware, chemicals | 29,400 short tons |
| Fullers Earth | Bleaching, filtering | 222,520 short tons |
| Gas, Natural | Carbon Black, petroleum refineries | 307,589 Million cu. ft. |
| Gasoline, Natural | Blended at refineries | 1,252,734 Thousand Gal. |
| Graphite | Paint, polishes, etc | 1,700 short tons |
| Gypsum | Plate glass, ceramics, etc | 82,000 short tons |
| Iodine | Chemicals, pharmaceuticals, etc | 310 short tons |
| Lead | Pigments | 127,500 short tons |
| Lime | Chemical | 1,570,000 short tons |
| Magnesite | Magnesium salts, rubber, paper, paint | 11,000 short tons |
| Manganese and Ores | Ceramics, chemicals | 2,785 short tons |
| Mercury | Chemicals, pharmaceuticals, vermilion | 500 short tons |
| Petroleum | Runs to stills | 996,243,000 bbl. |
| Phosphate Rock | Acid phosphate | 2,240,000 short tons |
| Platinum | Chemicals | 13,404 troy ounces |
| Potash ($K_2O$ content) | Fertilizer, chemicals | 420,000 short tons |
| Pyrites | Sulphuric acid | 1,012,000 short tons |
| Salt | Chemicals, leather, soap, food, textiles, etc | 6,600,000 short tons |
| Sand | Glass | 2,180,000 short tons |
| Silver | Chemicals | 11,000,000 troy ounces |
| Sodium Nitrate | Chemicals, fertilizer | 390,795 short tons |
| Sodium Sulphate | Pulp, chemicals, glass, textiles, etc | 149,000 short tons |
| Stone | Cement, lime, sugar, glass, etc | 26,772,000 short tons |
| Sulphur | Chemicals, pulp, explosives, pigments, dyes, rubber, etc | 1,450,000 short tons |
| Talc and Soapstone | Ceramics, paints, cosmetics | 190,000 short tons |
| Tin | Tin salts | 2,443 short tons |
| Titanium Dioxide | Pigments | 35,000 short tons |
| Zinc | Pigments | 155,000 short tons |

# GET THEIR RAW MATERIALS

## RAW MATERIALS OF NON-MINERAL ORIGIN

Domestic Production and Imports for 1935

Source: Minerals Yearbook, 1936


IMPORTS
Sugar cane 2997
Crude rubber 490
Cattle hides 43
Copra 277
Wood pulp 1865
Crude camphor 1
Flaxseed 492
Fats and Oils 914
In thousands of short tons
LEGEND
Cotton seed ---- 4,775,000 Tons
Sugar cane ---- 3,756,000 Tons (Cane)
Sugar beets ---- 7,984,000 Tons (Beets)
Flax seed ---- 14,931,000 Bu.
Soy beans ---- 43,631,000 Bu.
Wood pulp ---- 4,436,000 Tons
Hardwood distillation ---- 450,000 Cords.
Softwood distillation ---- 325000 Cords.
Naval stores (from Gum only)-505,000 Tons.
†Corn wet processed-60,000,000 Bu.
Produces
Corn starch ---- 318,000 Tons.
Corn sugar ---- 181,500 Tons.
Corn sirup ---- 471,000 Tons.
Dextrine ---- 36,000 Tons.
Corn Oil ---- 54,500 Tons.
Note:-All figures on the map indicate thousands of cords, bushels, or short tons, while those in the legend are actual values
△ Principal Cattle-producing States
+ Principal Wool-producing States
✳ Principal Mohair producing States
†Fats and Oils-1,250,000 Tons
† Production is not divisible by States

## SOME MAJOR RAW MATERIALS OF NON-MINERAL ORIGIN

| Material | Uses in Chemical Industry | Quantity Consumed in 1935 |
|---|---|---|
| Grains | | |
| Corn | Alcohol, starch, sugar, syrup, oil | 2,181,748 M-lb. |
| Rye | Alcohol | 15,284 M-lb. |
| Malt | Alcohol | 23,998 M-lb. |
| Cotton Linters | Rayon, explosives | 805,000 bales |
| Sugar beets | Sugar | 7,984,000 tons |
| Sugarcane | Sugar | 3,756,000 tons |
| Molasses | Alcohol | 180,802 M-gal. |
| Pulpwood | Paper | 6,797,000 cords |
| Turpentine | Solvent, paint, varnish, etc | 69,305 bbl. |
| Resin | Paper, soap, varnish, polishes, etc | 884,835 bbl. |
| Oil bearing materials | | |
| Cottonseed | Cottonseed oil | 3,844,254 short tons |
| Peanuts, hulled | Peanut oil | 23,861 short tons |
| Peanuts in the hull | Peanut oil | 53,278 short tons |
| Copra | Coconut oil | 199,577 short tons |
| Coconut and skins | Coconut oil | 1,651 short tons |
| Olives | Olive oil | 2,286 short tons |
| Flaxseed | Linseed oil | 731,910 short tons |
| Castor beans | Castor oil | 51,439 short tons |
| Soybeans | Soybean oil | 369,239 short tons |
| Mustard seed | Mustard oil | 660 short tons |
| Sesame seed | Sesame oil | 69,083 short tons |
| Rapeseed | Rapeseed oil | 14,000 short tons |
| Dye and tanning materials | | |
| Logwood | Tanning, textiles | 11,384 short tons |
| Myrobalans | Tanning, cotton dyeing and printing | 12,276 short tons |
| Quebracho | Tanning, dyeing and printing | 25,646 short tons |
| Sumac | Tanning, dyeing | 2,523 short tons |
| Valonia | Tanning | 11,157 short tons |
| Gambier | Tanning, dyeing and printing | 2,242 short tons |
| Wattle Bark | Tanning | 8,720 short tons |
| Nutgalls | Acids, ink, tanning, dyeing | 1,495 short tons |
| Pyrethrum | Insecticides | 5,000 short tons |
| Derris root | Insecticides | 500 short tons |
| Cube root | Insecticides | 250 short tons |
| Guano | Fertilizers | 22,568 short tons |
| Tankage | Fertilizers | 203,269 short tons |
| Fish scrap | Fertilizers | 83,883 short tons |
| Bones | Fertilizers | 26,002 short tons |
| Tallow, inedible | Soap and miscellaneous | 359,178 short tons |
| Grease | Soap, printing inks, etc | 100,111 short tons |
| Hard Wood | Methanol, acetic acid, acetate of lime, etc | 500,000 cords |

# AMERICAN CHEMICAL INDUSTRY AS AN EMPLOYER

EMPLOYMENT IN CHEMICAL MANUFACTURE has been regular, well paid and under favorable conditions of hours and safety. In a large measure, research has been responsible for this stabilization of the workers' well-being and income. But this research has required vision and a willingness to invest in new enterprise, constantly enlarging the service and opportunity of the industry.

There has been a steady increase in output of chemicals per worker employed. This is technological improvement; but no technological unemployment has resulted. Goods so made more efficiently, and thus at less cost, were sold more freely. Research created new industrial activity and new chemicals to aid business and employment. Altogether the result has been that the chemical industries have grown rapidly and have constantly afforded more stable, better-paid employment for all classes of workers.

The distribution of employees and the conditions of their employment have recently been analyzed in a critical study made by the National Industrial Conference Board for the Chemical Alliance, Inc. In the following pages we are privileged to present the preliminary results of these studies. Supplemented by the official figures from the U. S. Bureau of Labor Statistics, they give an excellent picture of a healthy, progressive relationship between management and workers in chemical industry.

# THESE ARE THE PEOPLE WHO MAKE AND SELL CHEMICALS

**BASED ON N.I.C.B. SURVEY OF 106,113 EMPLOYEES IN CHEMICAL MANUFACTURING INDUSTRIES**

29,875 — NORTH 26,566 — SOUTH 3,309 — **SALARIED WORKERS**

76,238 — NORTH 58,095 — SOUTH 18,143 — **HOURLY WORKERS**

| Weekly Income | NORTH | SOUTH | NORTH | SOUTH | Hourly Income |
|---|---|---|---|---|---|
| $50+ | 9,487 | 871 | 19,329 | 2,544 | 80¢+ |
| 40-50 | 4,107 | 657 | 12,026 | 2,658 | 70-80 |
| 32-40 | 4,283 | 661 | 14,424 | 2,733 | 60-70 |
| 24-32 | 4,692 | 682 | 7,881 | 3,487 | 50-60 |
| All Other | 3,997 | 438 | 4,435 | 6,721 | All Other |
| Total Earnings in 1936 | $27,724,113 | $5,109,261 | $75,460,760 | $19,247,617 | Total Earnings in 1936 |

## SALARIED EMPLOYEES PLAY A MORE IMPORTANT PART IN CHEMICAL INDUSTRY

CHEMICALS N.E.C. — CHEMICAL & ALLIED PROD. — CHEMICAL ALLIANCE SURVEY — CHEMICAL PROCESS IND. — ALL INDUSTRY

SALARIED WORKERS — IN PERCENTAGE OF TOTAL NUMBER OF EMPLOYEES — HOURLY WORKERS

**Chemists and Engineers**

NORTH 6,038 — SOUTH 623

**General Administrators***

NORTH 9,812 — SOUTH 1,048

**Factory Supervisors**

NORTH 4,774 — SOUTH 1,282

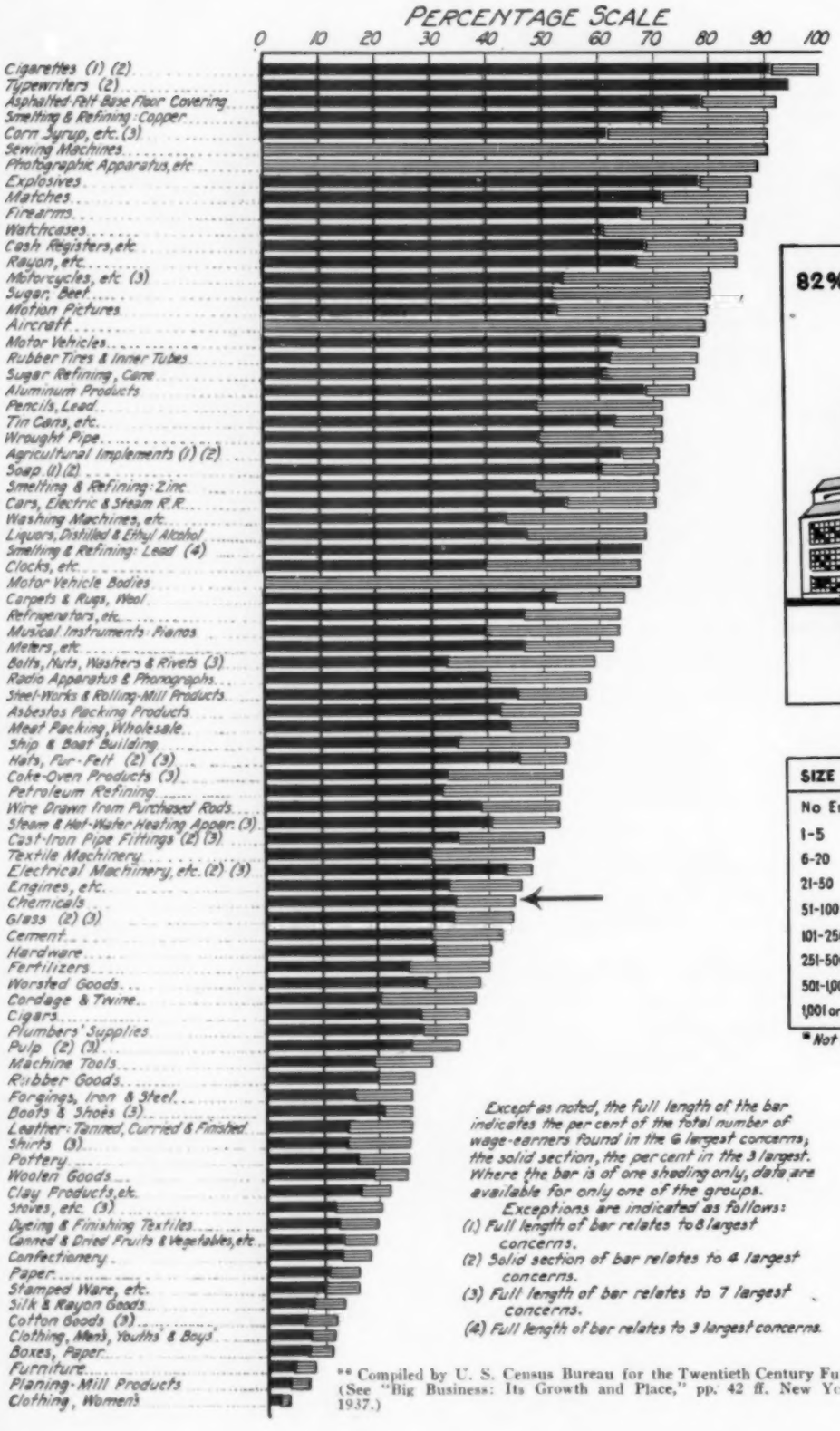
*Does not include corporate officers or major executives.

**Sales Personnel**

NORTH 5,942 — SOUTH 356

# HOW BIG ARE THE PLANTS IN CHEMICAL INDUSTRY?

**CONCENTRATION OF WAGE EARNERS IN 84 MANUFACTURING INDUSTRIES — 1933****



**82% OF ALL CHEMICAL WAGE-EARNERS**

**WORK IN PLANTS WITH LESS THAN 1,000 EMPLOYEES***

| SIZE OF UNITS | EMPLOYEES | ESTABLISHMENTS |
|---|---|---|
| No Employees* | 0.0% | 3.3% |
| 1-5 " | 0.4% | 13.7% |
| 6-20 " | 2.9% | 25.3% |
| 21-50 " | 7.3% | 22.2% |
| 51-100 " | 9.2% | 13.2% |
| 101-250 " | 19.0% | 12.0% |
| 251-500 " | 17.5% | 5.2% |
| 501-1,000 " | 26.1% | 3.8% |
| 1,001 or more " | 17.7% | 1.2% |

* Not operating

*Except as noted, the full length of the bar indicates the per cent of the total number of wage-earners found in the 6 largest concerns, the solid section, the per cent in the 3 largest. Where the bar is of one shading only, data are available for only one of the groups.*

*Exceptions are indicated as follows:*

*(1) Full length of bar relates to 8 largest concerns.*
*(2) Solid section of bar relates to 4 largest concerns.*
*(3) Full length of bar relates to 7 largest concerns.*
*(4) Full length of bar relates to 3 largest concerns.*

* 56% in plants with less than 500 and 38% in plants with 250 or less.

Source: N.I.C.B. for the Chemical Alliance, Inc., 1935.

** Compiled by U. S. Census Bureau for the Twentieth Century Fund. (See "Big Business: Its Growth and Place," pp. 42 ff. New York, 1937.)

**BEHIND EACH WORKER IN CHEMICAL INDUSTRY IS –**

Capital Assets $590,000,000
Working Capital $335,000,000
Total $925,000,000

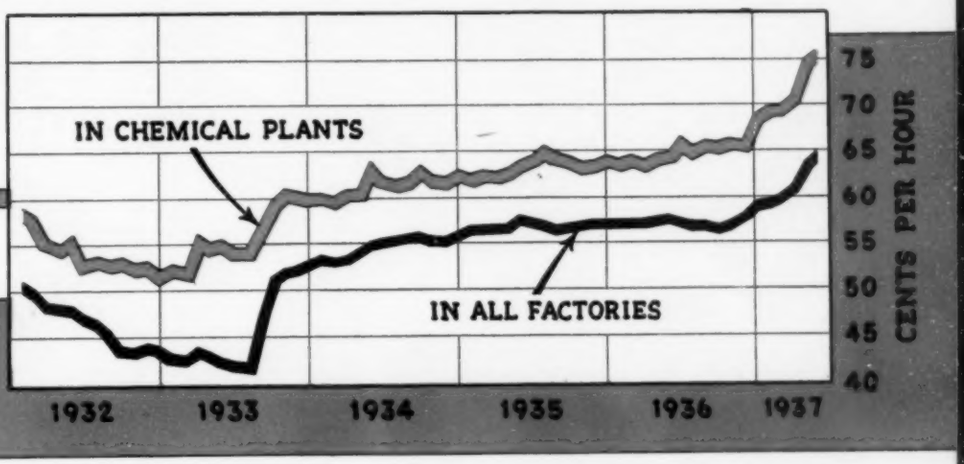
Hourly Workers 81,000
Salaried Workers 31,000
Total 112,000

**A CAPITAL INVESTMENT OF $8,260.00**

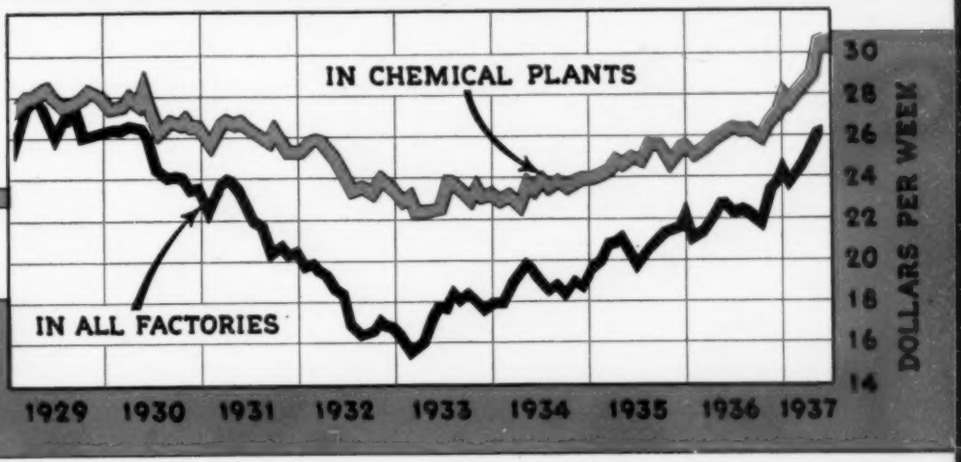
CHEM. & MET. ESTIMATES

# TRENDS IN HOURLY, WEEKLY AND "REAL" EARNINGS

**AVERAGE HOURLY EARNINGS**
Source: Department of Labor

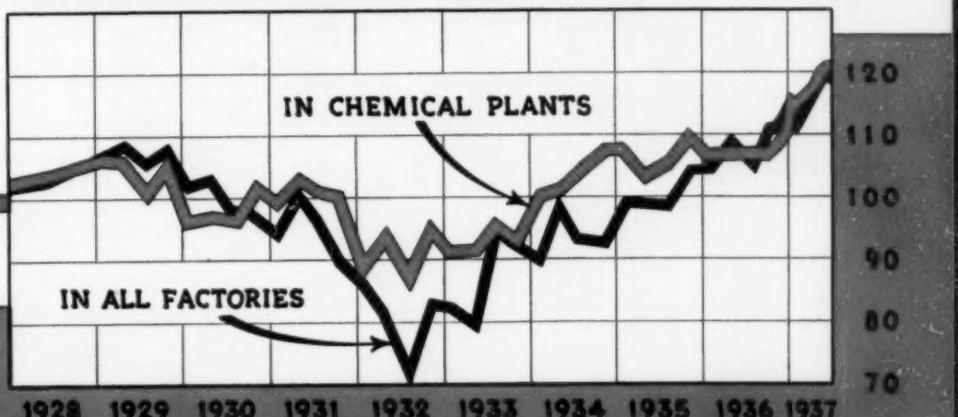


**AVERAGE WEEKLY EARNINGS**
Source: Department of Labor



**INDEX OF REAL WEEKLY EARNINGS**
(as adjusted to the Cost of Living)
1923=100

Source: National Industrial Conference Board



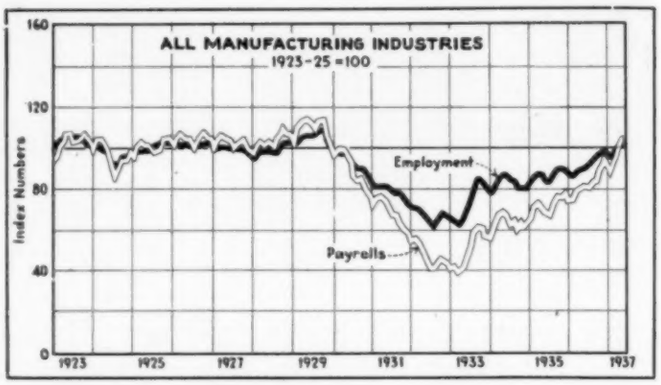
**Average Hours Worked per week and Average Hourly Earnings in Specified Industries.**

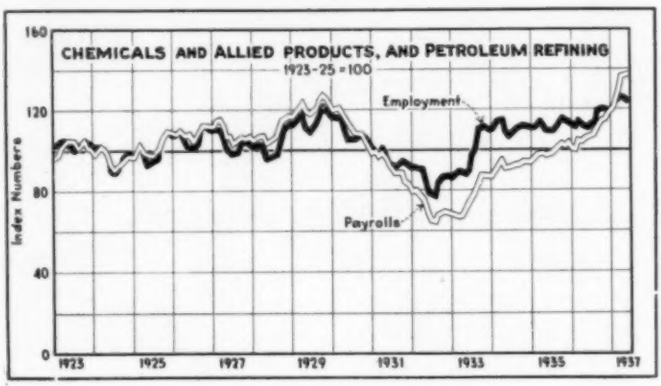
| Month and Year | Chemicals | | Explosives | |
|---|---|---|---|---|
| | Average hours worked per week | Average hourly earnings (cents) | Average hours worked per week | Average hourly earnings (cents) |
| 1932 | 42.4 | 54.5 | 34.3 | 58.6 |
| 1933 | 41.0 | 56.6 | 35.2 | 57.7 |
| 1934 | 38.6 | 61.6 | 34.6 | 62.5 |
| 1935 | 39.7 | 63.6 | 35.9 | 67.6 |
| 1936 | 40.6 | 65.3 | 39.6 | 70.6 |
| **1935** | | | | |
| January | 39.3 | 62.2 | 33.9 | 65.4 |
| February | 39.4 | 61.8 | 37.3 | 65.6 |
| March | 40.0 | 62.6 | 36.1 | 65.9 |
| April | 39.5 | 63.0 | 35.0 | 67.3 |
| May | 39.5 | 63.7 | 36.4 | 67.0 |
| June | 38.9 | 64.3 | 34.7 | 69.6 |
| July | 39.9 | 65.1 | 34.1 | 68.5 |
| August | 40.3 | 64.5 | 37.1 | 68.5 |
| September | 39.2 | 63.9 | 34.4 | 68.7 |
| October | 39.8 | 63.2 | 37.6 | 68.6 |
| November | 40.2 | 63.6 | 37.5 | 68.5 |
| December | 40.2 | 64.2 | 36.9 | 68.8 |
| **1936** | | | | |
| January | 39.6 | 63.8 | 35.9 | 69.4 |
| February | 39.8 | 64.1 | 38.8 | 68.7 |
| March | 40.7 | 63.8 | 40.3 | 68.8 |
| April | 40.9 | 64.3 | 38.0 | 69.2 |
| May | 41.0 | 64.6 | 39.1 | 70.4 |
| June | 40.7 | 65.3 | 39.7 | 71.5 |
| July | 39.7 | 65.9 | 38.7 | 71.8 |
| August | 40.7 | 65.5 | 39.7 | 70.9 |
| September | 40.1 | 65.7 | 40.4 | 70.8 |
| October | 40.8 | 65.7 | 41.6 | 70.2 |
| November | 41.6 | 65.9 | 40.6 | 71.1 |
| December | 41.3 | 68.8 | 41.9 | 73.6 |
| **1937** | | | | |
| January | 40.2 | 69.7 | 39.7 | 72.2 |
| February | 40.9 | 69.9 | 38.3 | 72.1 |
| March | 40.9 | 71.0 | 40.4 | 75.6 |
| April | 41.1 | 74.9 | 42.3 | 78.5 |
| May | 40.7 | 75.9 | 40.9 | 79.7 |
| June | 40.5 | 76.2 | 39.0 | 79.4 |

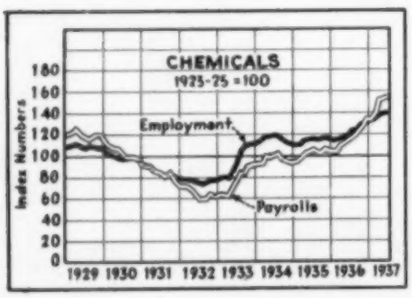
Data from Bureau of Labor Statistics, Dept. of Labor

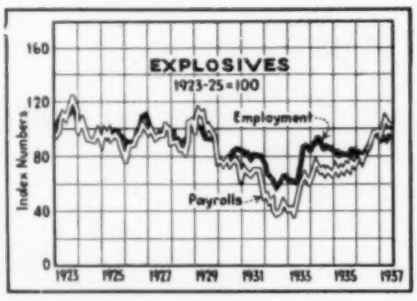
# THE RISING TRENDS IN IN CHEMICAL AND

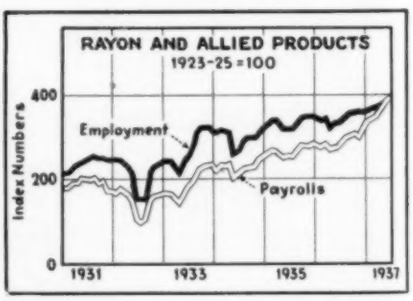
ALL DATA SUPPLIED BY U. S.

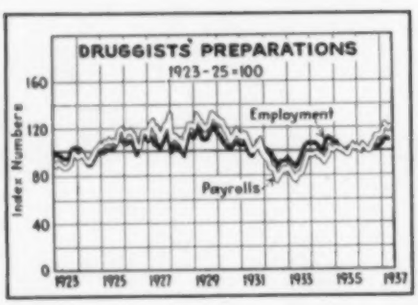


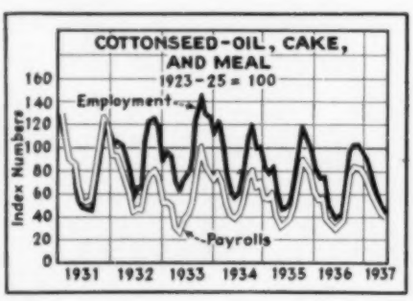



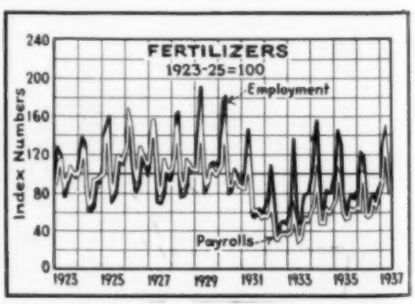



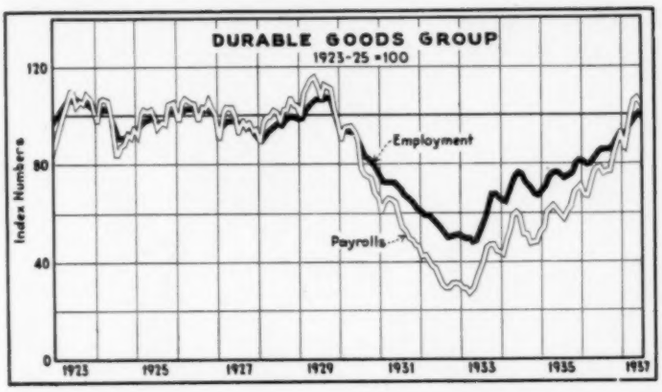



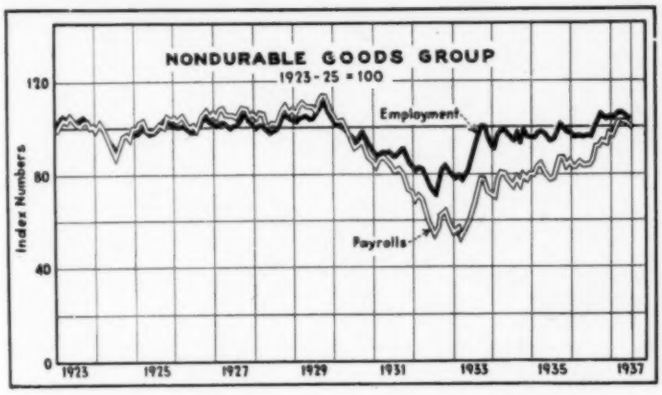



# EMPLOYMENT AND PAYROLLS PROCESS INDUSTRIES

BUREAU OF LABOR STATISTICS

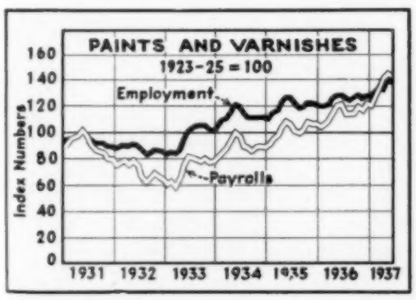


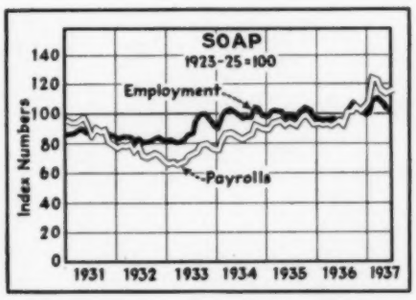



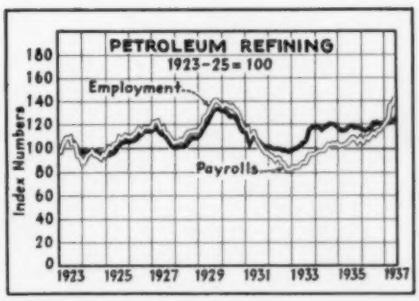

**Average Hours Worked per week and Average Hourly Earnings in Specified Industries.**

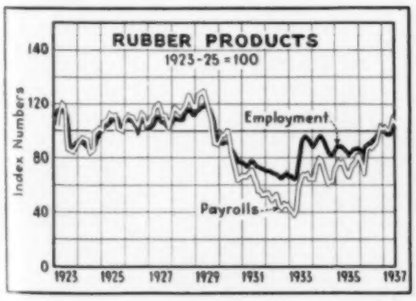
| Month and Year | Rayon | | Petroleum refining | |
|---|---|---|---|---|
| | Average hours worked per week | Average hourly earnings (cents) | Average hours worked per week | Average hourly earnings (cents) |
| 1932 | 43.5 | 39.8 | 42.2 | 63.2 |
| 1933 | 41.2 | 42.3 | 37.9 | 65.5 |
| 1934 | 37.0 | 50.3 | 34.9 | 75.0 |
| 1935 | 37.9 | 51.4 | 35.0 | 80.1 |
| 1936 | 38.6 | 53.2 | 35.8 | 82.7 |
| **1935** | | | | |
| January | 38.3 | 50.4 | 34.2 | 78.5 |
| February | 38.2 | 50.5 | 34.7 | 79.1 |
| March | 37.6 | 51.1 | 35.0 | 78.7 |
| April | 37.0 | 52.0 | 35.1 | 78.7 |
| May | 37.1 | 52.2 | 34.9 | 78.9 |
| June | 37.8 | 51.6 | 34.6 | 80.4 |
| July | 37.7 | 51.4 | 34.5 | 81.3 |
| August | 38.3 | 51.4 | 35.0 | 80.9 |
| September | 38.6 | 51.2 | 35.7 | 81.1 |
| October | 38.2 | 51.3 | 35.5 | 80.6 |
| November | 38.0 | 51.5 | 34.5 | 80.5 |
| December | 38.3 | 51.9 | 36.5 | 80.8 |
| **1936** | | | | |
| January | 38.3 | 52.1 | 35.5 | 80.4 |
| February | 38.2 | 52.4 | 34.8 | 81.8 |
| March | 38.8 | 52.1 | 36.2 | 82.0 |
| April | 39.1 | 52.4 | 35.5 | 81.4 |
| May | 38.6 | 52.3 | 36.3 | 81.0 |
| June | 38.8 | 52.2 | 36.2 | 81.8 |
| July | 38.7 | 52.8 | 35.4 | 83.0 |
| August | 39.3 | 52.8 | 35.3 | 83.9 |
| September | 38.9 | 53.2 | 35.1 | 84.0 |
| October | 39.0 | 53.7 | 35.8 | 83.5 |
| November | 37.0 | 54.8 | 36.5 | 83.9 |
| December | 38.4 | 57.0 | 36.5 | 85.7 |
| **1937** | | | | |
| January | 39.0 | 58.1 | 35.5 | 88.2 |
| February | 39.1 | 58.6 | 35.7 | 89.8 |
| March | 39.8 | 58.0 | 36.5 | 88.3 |
| April | 39.8 | 59.8 | 35.6 | 95.1 |
| May | 39.6 | 61.9 | 35.6 | 95.3 |
| June | 39.8 | 62.0 | 36.5 | 95.2 |

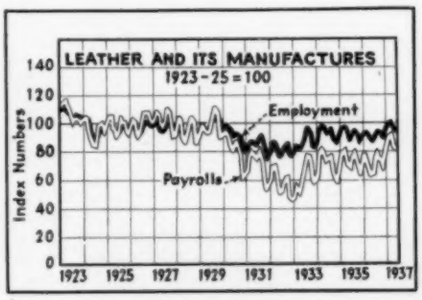
Data from Bureau of Labor Statistics, Dept. of Labor

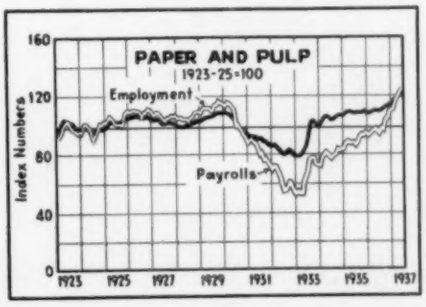


# FUEL AND POWER FOR AMERICAN CHEMICAL INDUSTRY

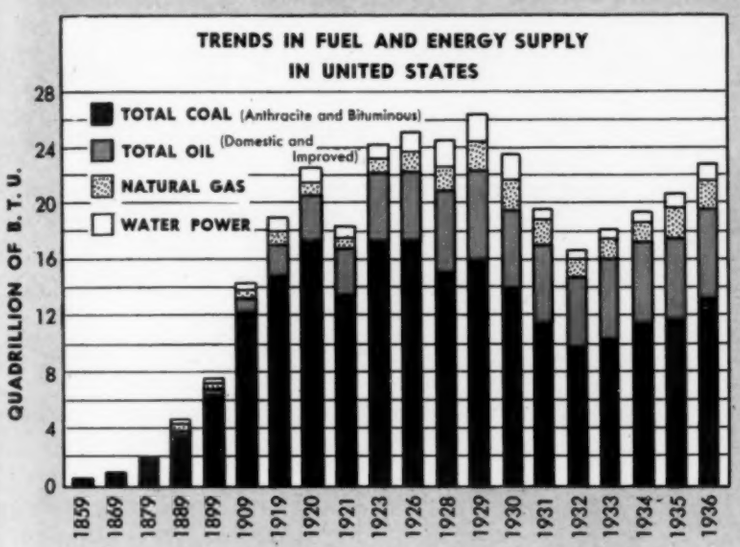
FUELS AND ELECTRICITY serve chemical industry in four ways: (1) as a source of heat for thermal processes, (2) as a source of power to energize equipment —literally to make the wheels go 'round, (3) as reagents in furnaces and electrolytic processes where fuel or electric energy seem to take an actual part in the chemical reaction, and (4) as raw materials for the manufacture of many important chemicals.

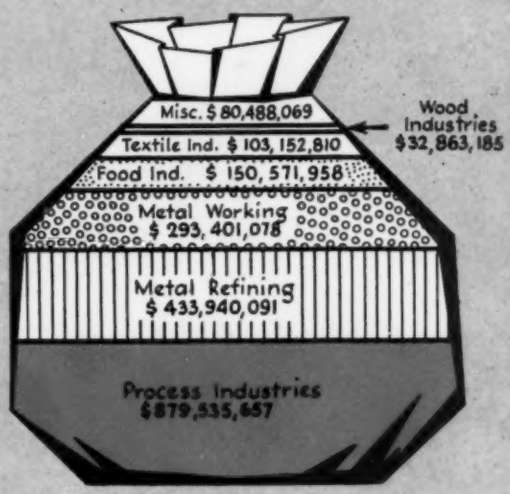
Chemical process industries pay nearly half of the nation's fuel bill because they require so much heat and mechanical power. But it is also well to remember that the great electrochemical and electrometallurgical industries would not be possible without the use of very cheap electric power. So the kilowatt takes its place with coal, oil and gas as a basic chemical raw material.

Considering chemical process industries as a whole, one must understand that the making of fuel is itself a chemical engineering business. The manufacture of coke, city gas, and other processed fuels requires chemical skill, precise control, and efficient equipment. Petroleum refining is almost wholly a chemical engineering enterprise. Indeed, in no other fuel industry has chemical technology made such a tremendous contribution to conservation and efficient use of a great natural resource.

# CHEMICAL PROCESS INDUSTRIES PAY ALMOST HALF OF NATION'S $2,000,000,000 BILL FOR FUEL AND POWER

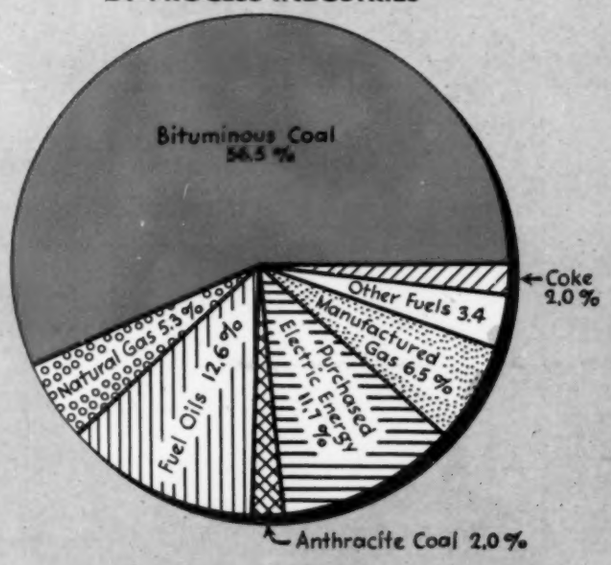
Data from Coal Economics Division of U. S. Bureau of Mines and U. S. Census of Manufactures for 1929. Fuel equivalent of water power is calculated from horsepower of hydro-electric installations.

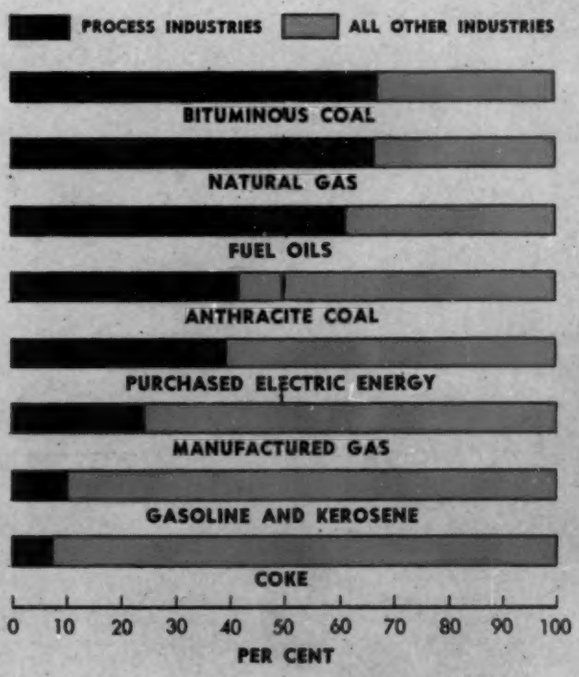


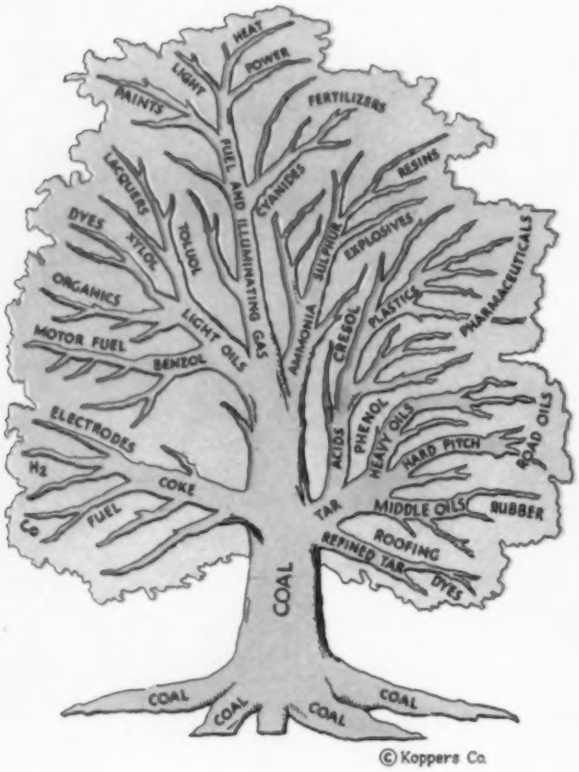

Process Industries Account for Two-Thirds of Industrial Consumption of Both Bituminous Coal and Natural Gas. Purchased Electric Energy, It Will Be Noticed, Finds a Relatively Much Smaller Consumer in the Chemical Industries.

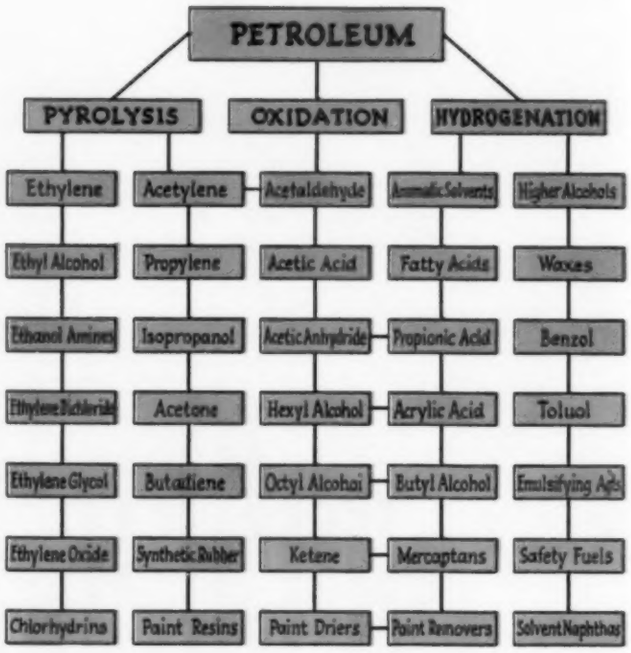
## HOW THE FUEL DOLLAR IS SPENT BY PROCESS INDUSTRIES



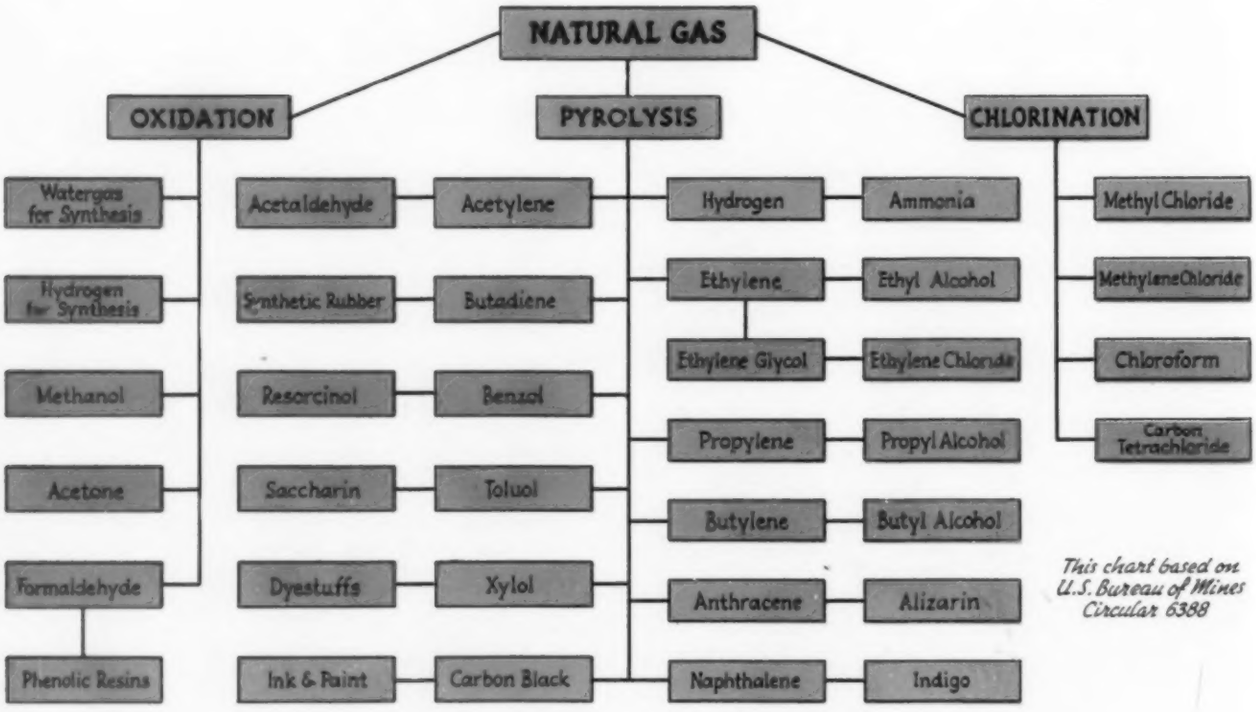



# COAL, OIL AND GAS ARE CHEMICAL RAW MATERIALS

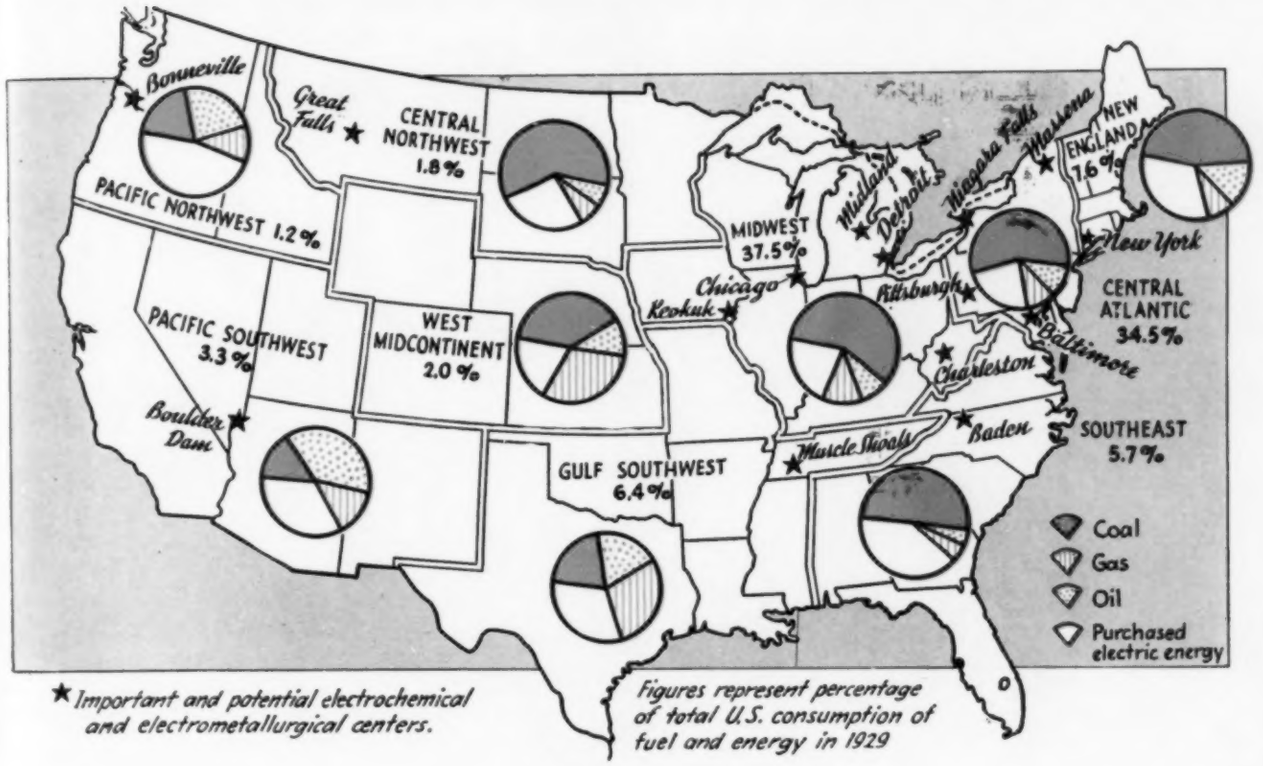



Some of the thousands of products made by chemical synthesis from materials that would otherwise be used solely for fuel purposes.




*This chart based on U.S. Bureau of Mines Circular 6388*



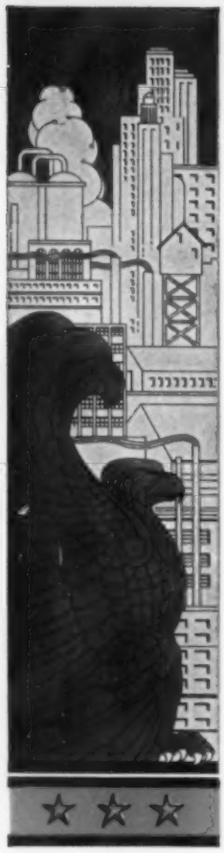

# WHERE KILOWATTS MAKE CHEMICALS AND METALS FOR INDUSTRY

**Power requirements of electrochemical processes and consumption of electricity in the United States in 1929**

SOURCE: U. S. WAR DEPT., HOUSE DOCUMENT 103, 73rd CONGRESS, 1st SESSION.

| Material | Process | Kilowatt-hours required per short ton | Total kw.-hr. consumed |
|---|---|---|---|
| 1. Alumina, fused | Electrothermal fusion | 2,000–2,540 | 43,318,000 [10] |
| 2. Aluminum | Electrothermal reduction of bauxite to alumina | 4,082–? | None |
| 3. Aluminum | Electrolytic reduction of alumina to aluminum | 19,000–25,200 | 2,519,375,000 |
| 4. Ammonia, Synthetic | Electrolytic hydrogen; pressure synthesis | 12,055 | 13,140,000 |
| 5. Cadmium | Electrolytic pptn. of zinc-lead residues | 2,000–2,500 | 2,730,200 |
| 6. Calcium Carbide | Electrothermal reduction | 2,600–3,200 | 720,000,000 |
| 7. Calcium Cyanamid | Electrothermal reduction | 2,830 | None [7] |
| 8. Carbon Bisulphide | Electrothermal fusion | 850 | 30,179,250 |
| 9. Caustic Soda, Chlorine | Electrolytic reduction of brine | 2,328–2,984 [9] | 660,000,000 |
| 10. Copper | Copper precipitation from oxide and mixed ore | 1,700–2,625 | 62,848,806 |
| 11. Copper | Electrolytic refining | 141–233 | 309,351,900 |
| 12. Copper Alloy | Electric furnace melting | 200–300 | 220,000,000 [11] |
| 13. Copper Alloy | Annealing | 50–100 | |
| 14. Copper Ingot | Melting | 310 | |
| 15. Ferro-Chromium, 60% | Electrothermal smelt | 6,000 | 228,258,000 |
| 16. Ferro-Manganese, 80% | Electrothermal reduction | 4,400 | None |
| 17. Ferro-Molybdenum, 70% | Electrothermal smelting | 8,000–9,000 | [6] |
| 18. Ferro-Silicon, 50% | Electrothermal smelting | 5,000 | 994,011,000 |
| 19. Ferro-Tungsten | Electrothermal smelting and refining | 7,600 | 26,395,000 |
| 20. Ferro-Uranium | Electrothermal smelting | 6,000–10,000 | [4] |
| 21. Ferro-Vanadium, 30-35% | Electrothermal smelting | 6,800 | 13,035,600 [4] |
| 22. Gold | Electrolytic refining | 266 | 45,300 |
| 23. Graphite, Crystalline | Electrothermal reduction | 7,600 | 91,200,000 [4] |
| 24. Hydrogen and Oxygen | Electrolytic reduction of water | 140 [12] | [13] |
| 25. Iron | Magnetic reduction in arc fur. | 2,000–2,500 | None |
| 26. Iron | Electrodeposition from ore | 900 | None |
| 27. Iron Castings | Electric melting | | |
| | Duplex system | 115 | [3] |
| | Continuous | 550 | |
| 28. Iron, Sponge | Electrothermal low temperature ore reduction | 400 | [3] |
| 29. Lead | Electrolytic refining | 95–111 | 6,180,000 |
| 30. Magnesium, Metallic | Electrolysis of magnesium chloride | 16,000 | 10,640,000 |
| 31. Phosphoric Acid | Electrothermal reduction | 5,400 | 81,000,000 |
| 32. Phosphorus | Electrothermal reduction | 9,000 | 1,250,000 [4] |
| 33. Potassium Chlorate | Electrolysis of potassium chloride | 1,350 | [3] |
| 34. Potassium Hydroxide | Electrolysis of potassium chloride | 2,100–2,300 | 15,831,000 |
| 35. Sodium, Metallic | Electrolysis of fused caustic soda | 13,000 | [3] |
| 36. Quartz, fused | Electrothermal fusion | 10,000–16,000 | [3] |
| 37. Silicon | Electrothermal reduction | 12,000 | [3] |
| 38. Silicon Carbide | Electrothermal reduction | 6,666–8,333 | 23,655,000 [5] |
| 39. Silver | Electrolytic refining | 316–714 | 1,283,460 |
| 40. Steel | Electric annealing or hardening | 182–286 | |
| 41. Steel | Electric galvanizing or Electroxincing | 101–230 | |
| 42. Steel Castings | Electric melting solid charge | 500–790 | 281,594,000 [4] |
| 43. Steel Ingot | Electric melting or refining or super-refining of molten charge | 210 | 125,218,590 |
| 44. Zinc | Electrolytic precipitation | 2,206–3,200 | 507,115,192 [8] |

[1] Does not include 15 rare metals or chemicals, the production of which is still on a very small scale.
[2] United States production not officially recorded. Estimated world electricity consumption in manufacture of metallic sodium in 1927 was 375,000,000 kilowatt-hours.
[3] United States production too small to be officially recorded.
[4] Estimated.
[5] Canadian and United States consumption in 1929 was 227,000,000 kilowatt-hours.
[6] Included in figure for ferro-chromium.
[7] The amount shipped to the United States in 1929 required 84,900,000 kilowatt-hours.
[8] Includes power required in operations immediately essential to electrolytic precipitation.
[9] Per ton of caustic soda.
[10] Canadian and United States consumption in 1929 was 152,489,000 kilowatt-hours.
[11] Figures are for 1927.
[12] Kilowatt-hours per 1,000 cu.ft.
[13] Process employed chiefly in plants where hydrogen is consumed in major manufacturing processes.



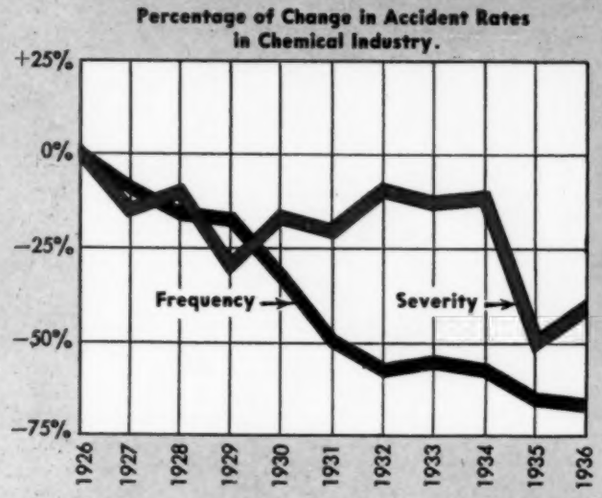
# CHEMICAL INDUSTRY PROMOTES HEALTH AND SAFETY

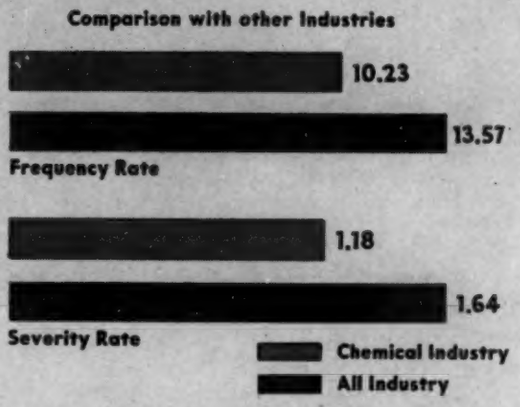
CHEMICALS SERVE public health and safety in so many ways that it would be unfortunate if their great services had to be offset by undue danger in manufacture, distribution or use. Fortunately, they do not. Potential hazards have been eliminated as far as humanly possible by careful planning and precautions, aided by real cooperation of manufacturers, chemical workers, and the transportation and user industries.

Chemical manufacture is a relatively safe division of American industry—in fact far safer in practice than many older businesses which seem relatively less hazardous. Governmental and industrial records confirm this conclusion. And it is noteworthy that a large percentage of the accidents in chemical manufacture are of those simple types which may occur anywhere—tripping, falling, being hit by falling objects, and like misfortunes that one may experience even in the home.

The industry has recognized its public responsibilities in matters of safety. When new compounds are devised, they are subjected to the most painstaking study to determine whether or not their use for any proposed purpose is safe. Where toxic properties or other hazards are inevitable accompaniments of important industrial service, the industry works with the government in advancing proper limitations on use, proper protection for workers, proper containers and proper methods of labeling and handling in transport. As a result, the health service of chemical industry is in fact *not* offset by public or industrial risks. Truly, the safety records of the industry are most enviable.

## SAFETY IN MANUFACTURE



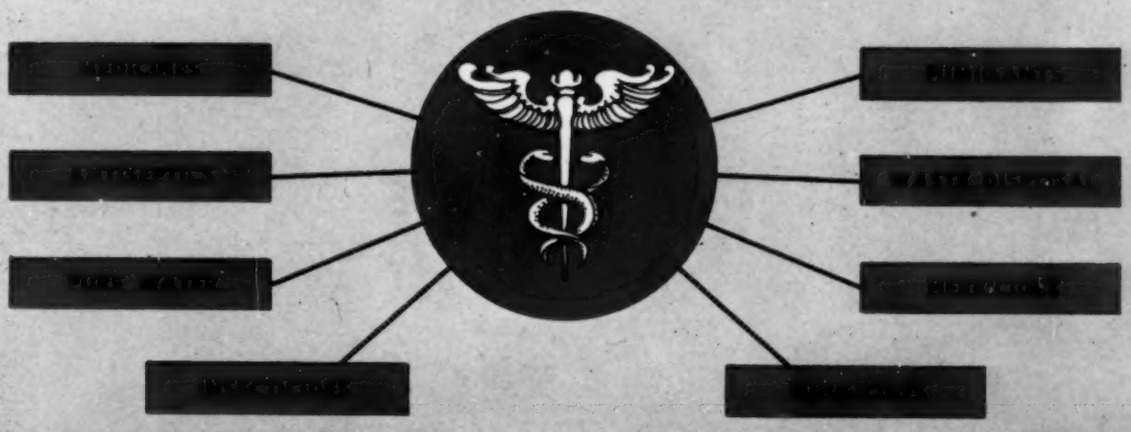

Accident frequency and severity rates for chemical industry have fallen markedly during the past 10 years and are 24 and 29 per cent respectively below the averages for all industries, according to the comprehensive statistics of the National Safety Council.

## SAFETY IN DISTRIBUTION

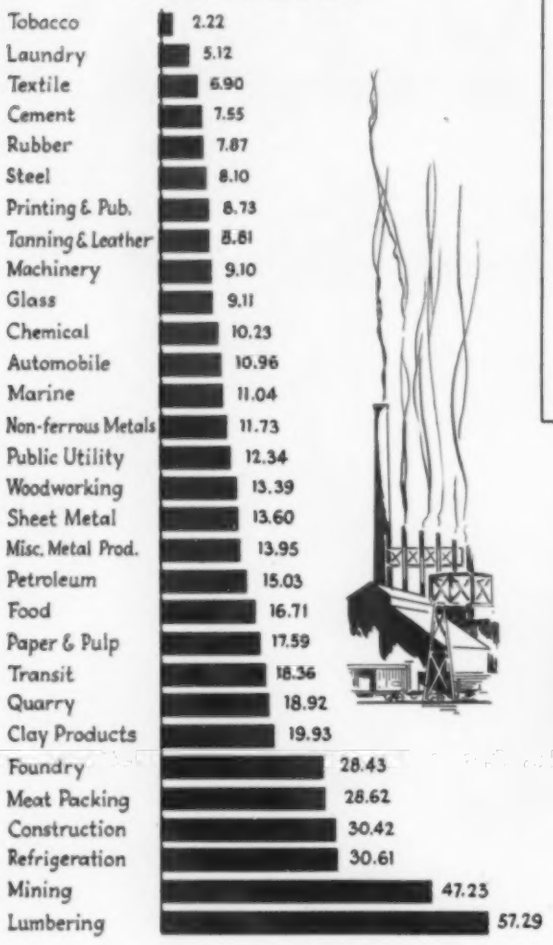
| 1917 — 1920 AVERAGE | | 1933 — 1936 AVERAGE |
|---|---|---|
| 810 | ACCIDENTS | 118 |
| 26 | INJURIES | 7 |
| $141,094 | PROPERTY LOSS | $7,668 |
| 0 | DEATHS | 0 |

In handling all railroad shipments of the 5 principal acids, the Bureau of Explosives reports that accidents have been reduced by 85 per cent, injuries by 75 per cent and property loss by 95 per cent during the last 20 years.

## IN SERVING THE PUBLIC WELFARE

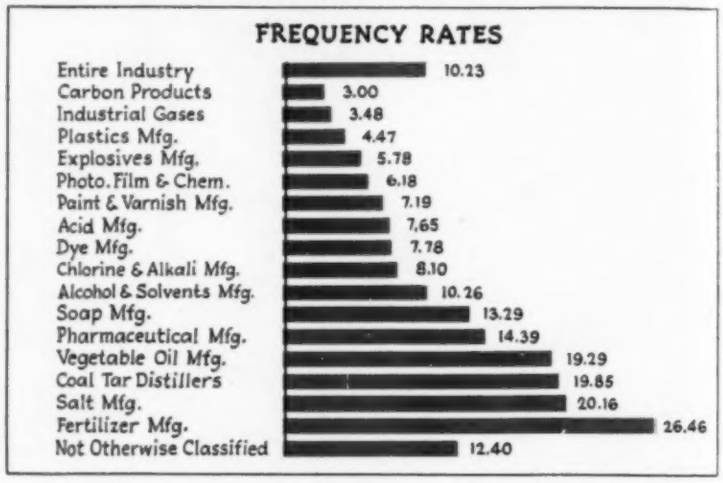


## CHEMICALS RANK ELEVENTH IN INJURY FREQUENCY RATES FOR 1936

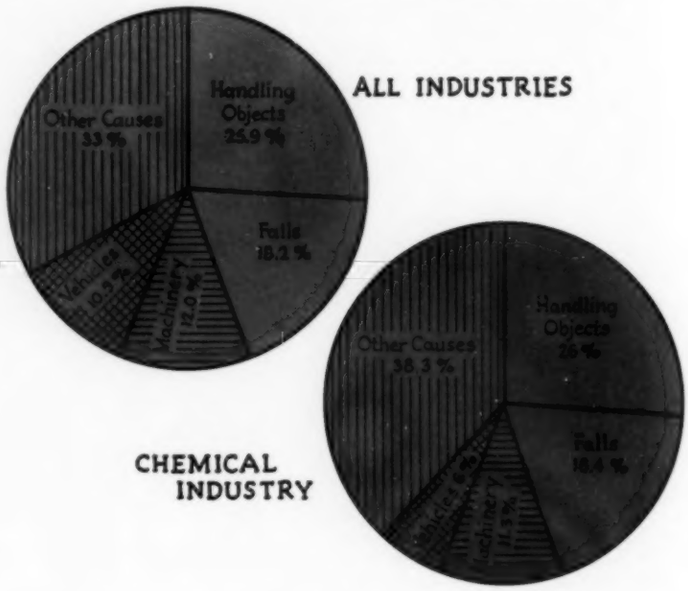



Source: *Reports of industrial establishments to the National Safety Council*

## HOW CHEMICAL INDUSTRIES STAND IN EMPLOYEE SAFETY




## COMMON CAUSES OF ACCIDENTS

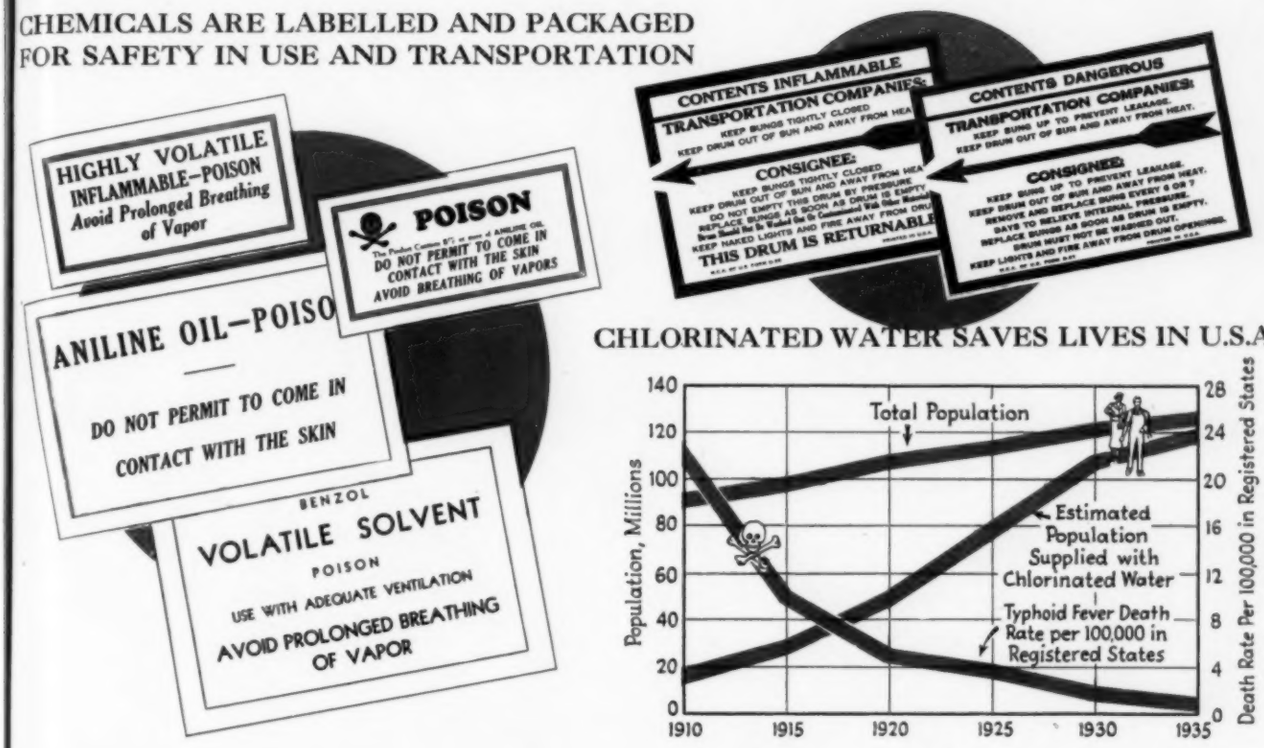



## SAFETY RECORDS OF CHEMICAL INDUSTRIES IN 1936

SOURCE: "ACCIDENT RATES IN THE CHEMICAL INDUSTRY," CHEMICAL SECTION, NATIONAL SAFETY COUNCIL.

| Industrial Group | No. of Industrial Units | Man-Hours Worked (Thousands) | Average Number of Employees | No. Disabling Injuries: Death and Perm. Total | Perm. Partial | Temporary | Total | Time Charges: Death and Perm. Total | Perm. Partial | Temporary | Total | Injury Rates: Frequency | Severity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All Groups | 305 | 232,205 | 121,504 | 27 | 143 | 2,411 | 2,581 | 162,000 | 95,364 | 40,361 | 297,725 | 10.23 | 1.18 |
| Carbon Products | 12 | 9,333 | 4,463 | 1 | 3 | 24 | 28 | 6,000 | 4,183 | 496 | 10,679 | 3.00 | 1.14 |
| Industrial Gases | 10 | 3,731 | 1,796 | 0 | 1 | 12 | 13 | 0 | 100 | 232 | 332 | 3.48 | .09 |
| Plastics Manufacturing | 9 | 13,425 | 6,441 | 2 | 14 | 44 | 60 | 12,000 | 7,510 | 482 | 19,992 | 4.47 | 1.49 |
| Explosives Manufacturing | 28 | 16,605 | 8,106 | 3 | 8 | 85 | 96 | 18,000 | 4,250 | 1,400 | 23,650 | 5.78 | 1.42 |
| Photographic Film and Chemicals | 5 | 33,184 | 16,760 | 1 | 13 | 191 | 205 | 6,000 | 9,280 | 4,706 | 19,986 | 6.18 | .60 |
| Paint and Varnish Manufacturing | 22 | 16,833 | 8,099 | 1 | 3 | 117 | 121 | 6,000 | 5,100 | 2,240 | 13,340 | 7.19 | .79 |
| Acid Manufacturing | 16 | 16,204 | 7,865 | 4 | 14 | 106 | 124 | 24,000 | 5,737 | 2,101 | 31,838 | 7.65 | 1.96 |
| Dye Manufacturing | 6 | 12,846 | 6,173 | 1 | 9 | 90 | 100 | 6,000 | 3,540 | 1,833 | 11,373 | 7.78 | .89 |
| Chlorine and Alkali Manufacturing | 8 | 8,891 | 4,137 | 1 | 5 | 66 | 72 | 6,000 | 4,288 | 1,444 | 11,732 | 8.10 | 1.32 |
| Alcohol and Solvents Mfg. | 6 | 1,949 | 935 | 0 | 0 | 20 | 20 | 0 | 0 | 148 | 148 | 10.26 | .08 |
| Soap Manufacturing | 31 | 23,848 | 11,765 | 0 | 21 | 296 | 317 | 0 | 11,888 | 5,206 | 17,094 | 13.29 | .72 |
| Pharmaceutical and Fine Chemical Manufacturing | 27 | 31,200 | 14,926 | 1 | 9 | 439 | 449 | 6,000 | 9,568 | 5,097 | 20,665 | 14.39 | .66 |
| Vegetable Oil Manufacturing | 29 | 6,895 | 3,478 | 3 | 13 | 117 | 133 | 18,000 | 9,105 | 1,677 | 28,782 | 19.29 | 4.17 |
| Coal Tar Distillers | 18 | 1,713 | 813 | 0 | 0 | 34 | 34 | 0 | 0 | 355 | 355 | 19.85 | .21 |
| Salt Manufacturing | 12 | 4,663 | 2,141 | 0 | 0 | 94 | 94 | 0 | 0 | 1,384 | 1,384 | 20.16 | .30 |
| Fertilizer Manufacturing | 8 | 5,971 | 2,447 | 5 | 5 | 148 | 158 | 30,000 | 715 | 3,988 | 34,703 | 26.46 | 5.81 |
| Not Otherwise Classified | 58 | 44,914 | 21,219 | 4 | 25 | 528 | 557 | 24,000 | 20,100 | 7,572 | 51,672 | 12.40 | 1.15 |

## CHEMICALS ARE LABELLED AND PACKAGED FOR SAFETY IN USE AND TRANSPORTATION


HIGHLY VOLATILE
INFLAMMABLE—POISON
Avoid Prolonged Breathing of Vapor
POISON
DO NOT PERMIT TO COME IN CONTACT WITH THE SKIN
AVOID BREATHING OF VAPORS
ANILINE OIL—POISO
DO NOT PERMIT TO COME IN
CONTACT WITH THE SKIN
BENZOL
VOLATILE SOLVENT
POISON
USE WITH ADEQUATE VENTILATION
AVOID PROLONGED BREATHING OF VAPOR
CONTENTS INFLAMMABLE
TRANSPORTATION COMPANIES:
KEEP BUNGS TIGHTLY CLOSED
KEEP DRUM OUT OF SUN AND AWAY FROM HEA
CONSIGNEE:
KEEP BUNGS TIGHTLY CLOSED
KEEP DRUM OUT OF SUN AND AWAY FROM HEAT
DO NOT EMPTY THIS DRUM BY PRESSURE
REPLACE BUNGS AS SOON AS DRUM IS EMPTY
KEEP NAKED LIGHTS AND FIRE AWAY FROM DRU
THIS DRUM IS RETURNABLE
CONTENTS DANGEROUS
TRANSPORTATION COMPANIES:
KEEP BUNG UP TO PREVENT LEAKAGE.
KEEP DRUM OUT OF SUN AND AWAY FROM HEAT.
CONSIGNEE:
KEEP BUNG UP TO PREVENT LEAKAGE.
KEEP DRUM OUT OF SUN AND AWAY FROM HEAT.
REMOVE AND REPLACE BUNG EVERY 6 OR 7
DAYS TO RELIEVE INTERNAL PRESSURE.
REPLACE BUNGS AS SOON AS DRUM IS EMPTY.
DRUM MUST NOT BE WASHED OUT.
KEEP LIGHTS AND FIRE AWAY FROM DRUM OPENINGS.

## CHLORINATED WATER SAVES LIVES IN U.S.A.



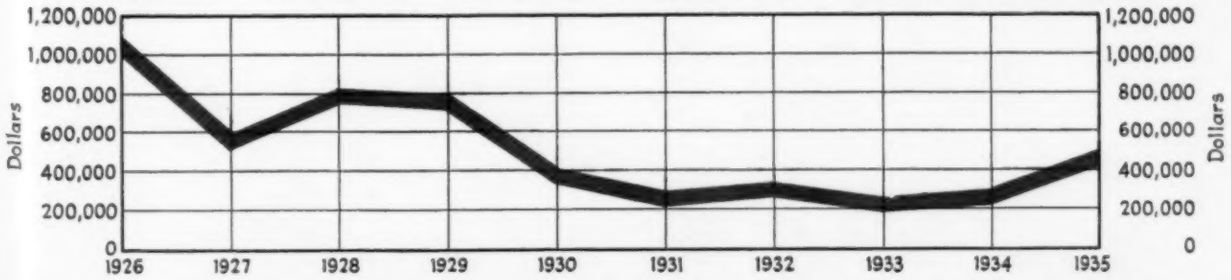

## COMPARATIVE SUMMARY SHOWING RAILWAY TRANSPORTATION LOSSES CHARGEABLE TO CHEMICALS, EXPLOSIVES AND OTHER DANGEROUS ARTICLES, 1926-36

SOURCE: BUREAU OF EXPLOSIVES OF THE ASSOCIATION OF AMERICAN RAILWAYS

| CLASS | No. of Accidents | Persons Killed | Persons Injured | Property Loss | Per Cent. of Total Property Loss |
|---|---|---|---|---|---|
| Explosives | 67 | 0 | 1 | $230 | 0.044 |
| Acids and Corrosive Liquids | 312 | 0 | 11 | 6,808 | 1.294 |
| Inflammable Liquids** | 674 | 4 | 8 | 501,668 | 95.364 |
| Inflammable Solids and Oxidizing Materials | 60 | 0 | 5 | 14,887 | 2.829 |
| Compressed Gases | 14 | 0 | 9 | 259 | 0.050 |
| Poisonous Liquids and Solids | 6 | 0 | 0 | Slight | ..... |
| Forbidden Articles | 1 | 0 | 0 | 2,205 | 0.419 |
| Totals, 1936 | 1134 | 4 | 34 | $526,057 | ..... |
| Totals 1935* | 1102 | 9 | 34 | $525,801 | ..... |
| Totals 1934* | 1480 | 6 | 68 | 342,949 | ..... |
| Totals 1933* | 902 | 6 | 12 | 298,157 | ..... |
| Totals 1932* | 648 | 2 | 19 | 379,408 | ..... |
| Totals 1931* | 852 | 0 | 20 | 323,769 | ..... |
| Totals 1930* | 1166 | 9 | 24 | 447,249 | ..... |
| Totals 1929* | 1266 | 5 | 30 | 832,997 | ..... |
| Totals 1928* | 1398 | 15 | 109 | 871,001 | ..... |
| Totals 1927* | 1344 | 5 | 34 | 633,004 | ..... |
| Totals 1926* | 1514 | 3 | 36 | 1,131,376 | ..... |

* Corrected figures. ** Principally gasoline and motor fuels.

## PROPERTY LOSSES IN RAILROAD TRANSPORTATION OF CHEMICALS



# AMERICAN CHEMICAL INDUSTRY CREATED BY RESEARCH

RESEARCH NOT ONLY STABILIZES and improves industry, but it actually creates new types of business. This is particularly true of the American chemical industry which has grown in magnitude and service, largely because it is the major patron of industrial research in this country.

Even during depression times, there were in the United States approximately 1600 industrial research laboratories with more than 22,000 technically trained men and women at work. Process industries were outstandingly first in rank as to number of laboratories, number of investigators and amount of money expended. During the current year, chemical manufacturers alone will spend at least $20,000,000 and process industries several times this total.

Educational records also show the growing importance of chemical research. Nearly one-third of all of the doctorate degrees conferred by American universities are in the field of chemistry and chemical engineering. Over 3,000 graduate students are engaged in chemical research during their postgraduate college years. And today the demand for graduate degrees in chemical engineering exceeds the demand in all other divisions of engineering combined.

Research creates, chemical engineering develops and chemical industry makes commercially possible the advances of science. The result is human benefit, as well as industrial achievement, worth many times the immediate cost in dollars and cents.

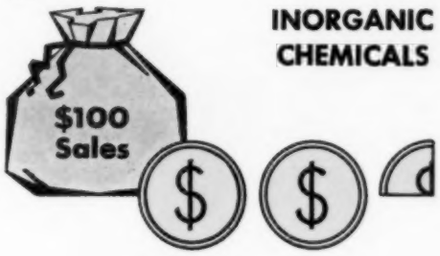
## CHEMICAL MANUFACTURERS ARE SPENDING

# $20,000,000

## FOR RESEARCH IN 1937

Out of

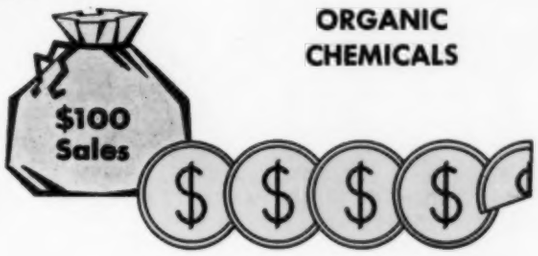
INORGANIC CHEMICALS




**$2.25** For Research

Out of

ORGANIC CHEMICALS




**$4.30** For Research

### THE RESULTS AND BENEFITS OF RESEARCH ARE:

1. New and improved processes
2. Lower costs and lower prices of products
3. New services and new products never before known
4. Change of rarities to commercial supplies of practical usefulness
5. Adequate supply of chemicals previously obtained only as byproducts.
6. Freedom for American users from foreign monopoly control
7. Stabilization of business and of industrial employment
8. Products of greater purity
9. Products of superior service, e.g., light-fast dyes
10. New medicines and other new health aids
11. More efficient use of raw materials
12. More efficient byproduct recovery

**OR**

CREATION OF NEW INDUSTRY AND STABILIZATION OF OLD.

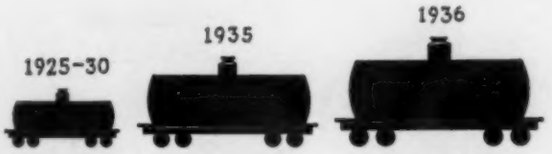
# SOME THINGS RESEARCH HAS DONE

## IT HAS INCREASED PRODUCTION

### OF NEW SYNTHETIC MEDICINES

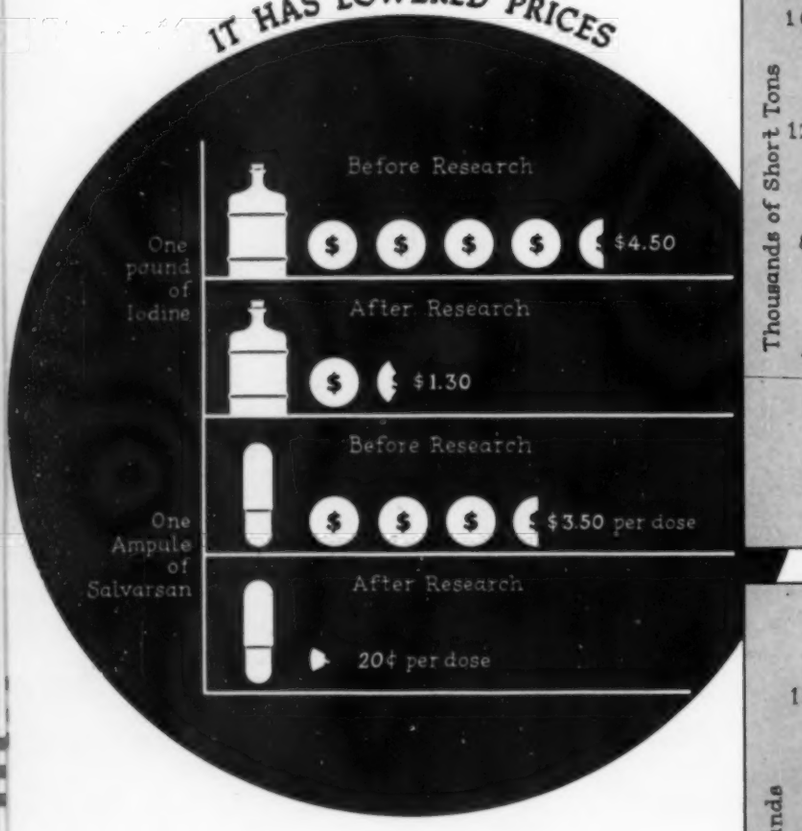
4,500,000 lb. $7,500,000 value | 10,000,000 lb. $8,400,000 value | 12,000,000 lb. $ 9,800,000 value

### OF NEW ORGANIC SOLVENTS

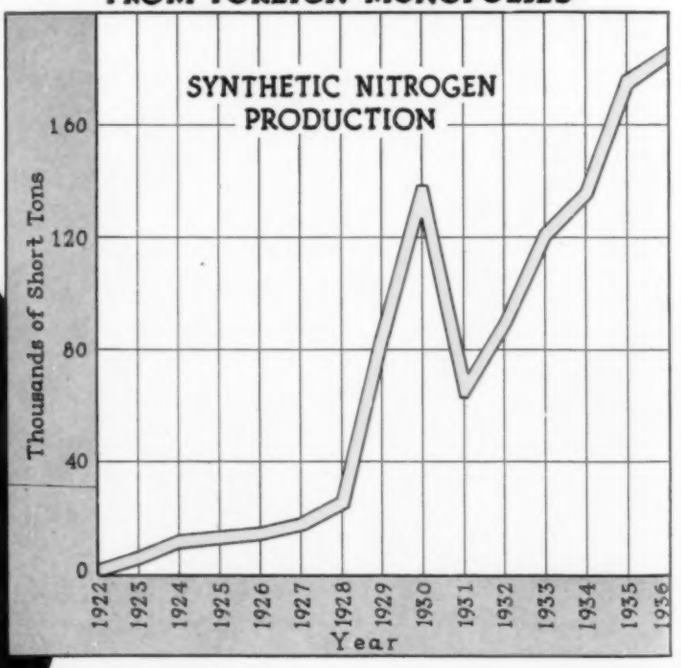


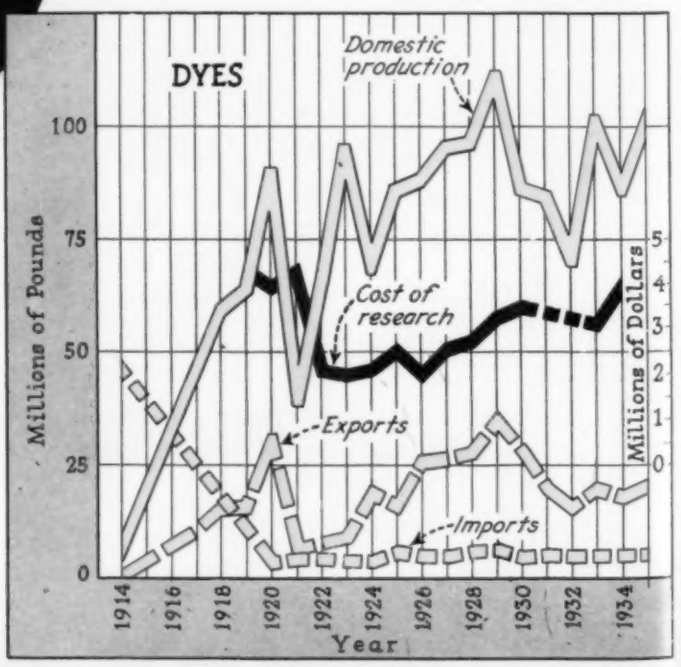

380,000,000 lb. $45,000,000 val. | 1,600,000,000 lb. $ 86,000,000 value | 2,000,000,000 lb. $ 106,000,000 value

## IT HAS LOWERED PRICES




## IT HAS FREED INDUSTRIES FROM FOREIGN MONOPOLIES

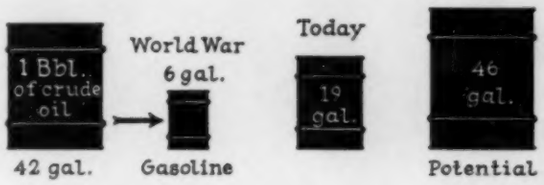


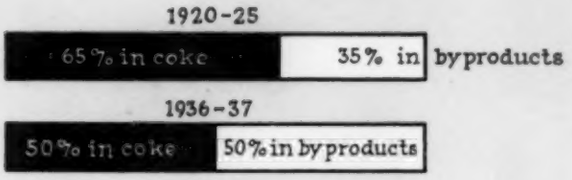
# FOR AMERICAN CHEMICAL INDUSTRIES

## IT HAS INCREASED YIELDS

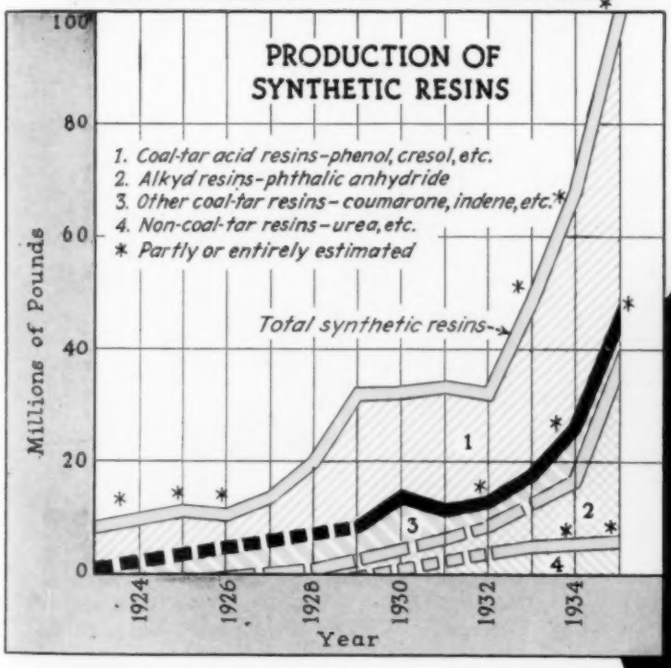
### IN PETROLEUM REFINING

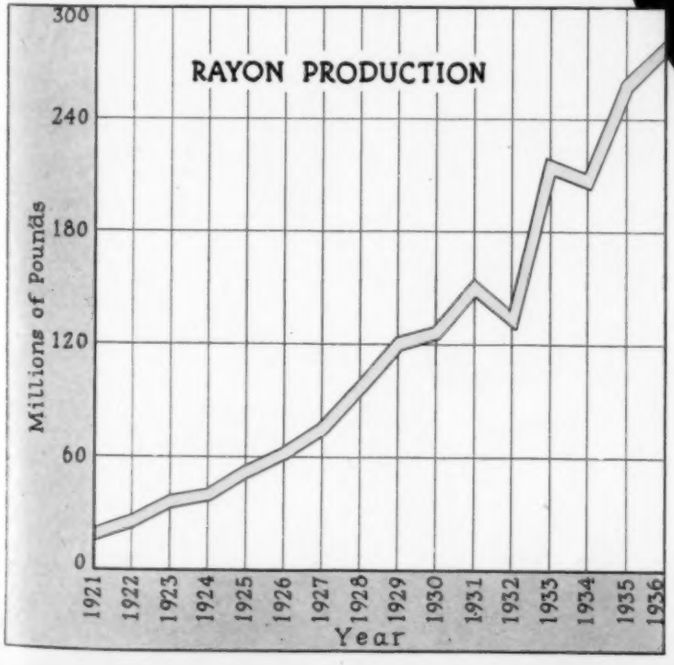



### IN COAL CARBONIZATION

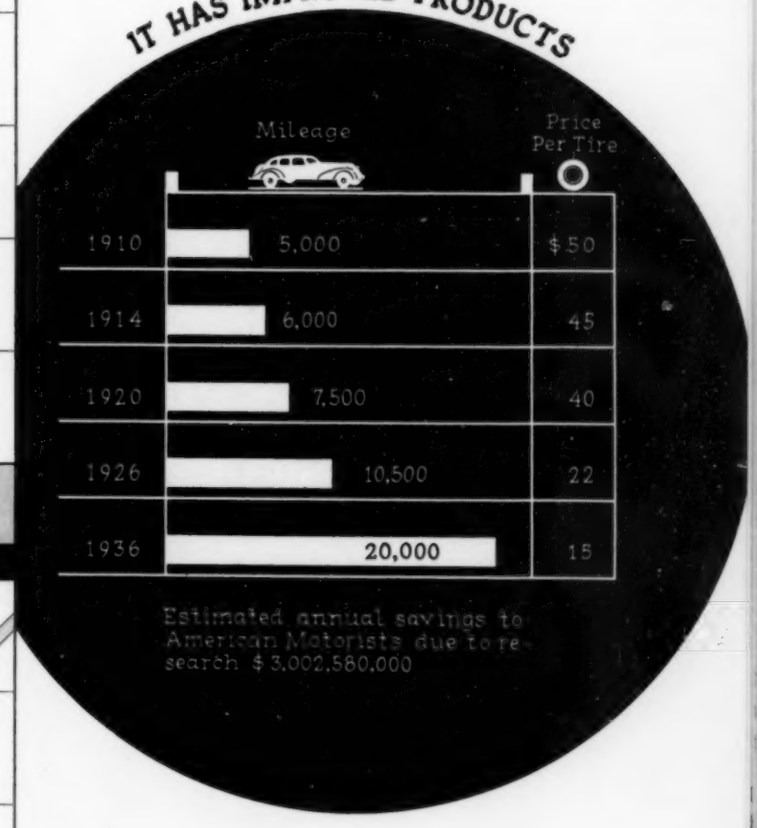



## IT HAS CREATED NEW INDUSTRIES


PRODUCTION OF SYNTHETIC RESINS
1. Coal-tar acid resins-phenol, cresol, etc.
2. Alkyd resins-phthalic anhydride
3. Other coal-tar resins-coumarone, indene, etc.*
4. Non-coal-tar resins-urea, etc.
* Partly or entirely estimated
Total synthetic resins
Millions of Pounds
Year




## IT HAS IMPROVED PRODUCTS

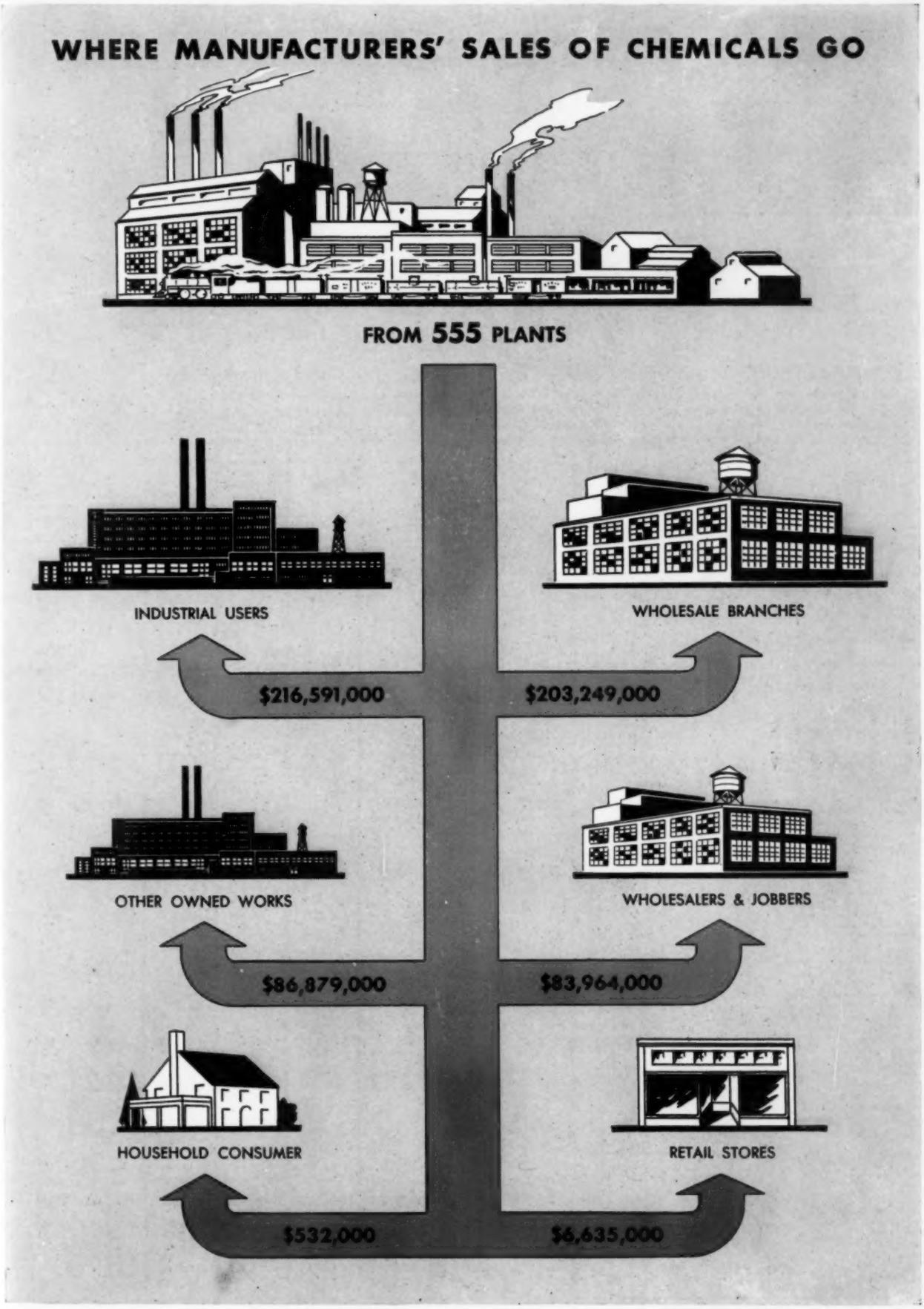


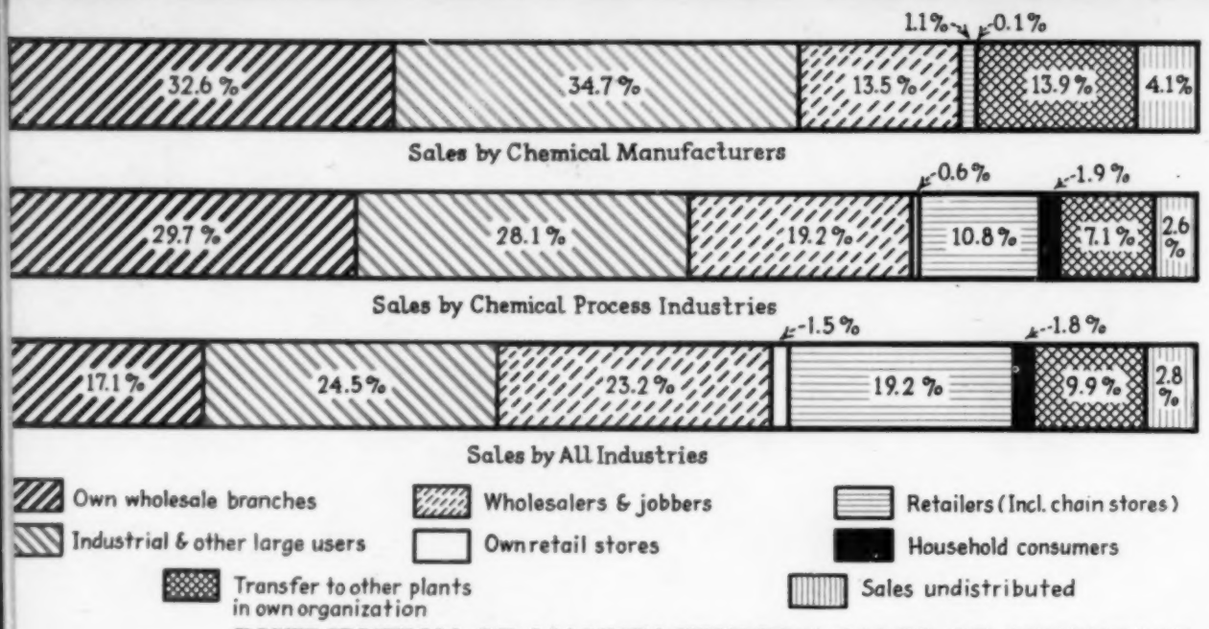
# SELLING THE PRODUCTS OF AMERICAN CHEMICAL INDUSTRY

MARKETING OF CHEMICALS is, in many respects, no different than the selling of other industrial goods. But the greater proportion of chemicals sold directly to the industrial user, as contrasted with the quantity sold by dealers or ultimately at retail, does produce a significant modification of marketing methods. And, fortunately, it considerably reduces the costs of distribution for most chemical commodities.

From the U. S. Census of 1935, one may obtain for the first time a true picture of the way in which manufacturers accomplish the primary marketing of their goods. The accompanying data make clear that the chemical and allied industries have achieved this primary marketing with a minimum of mark-up from factory costs. Broadly speaking, the cost of primary selling of chemicals is about 8 per cent of the factory cost, a very reasonable charge when one compares it with selling expenses involved in many other lines of business. There are, to be sure, some other classes of industrial goods sold at a lower percentage of mark-up, but they are the products of industries which happen to be even more fortunate than chemical makers in the small number of customers who need be reached.

In considering the figures and charts of this section, it should be understood that the data do not relate to the expenses of wholesalers or retailers. They are confined solely to the expenses of the manufacturer in the primary marketing work. Middlemen are not dominating factors in the distribution of most chemicals.


WHERE MANUFACTURERS' SALES OF CHEMICALS GO
FROM 555 PLANTS
INDUSTRIAL USERS
WHOLESALE BRANCHES
$216,591,000
$203,249,000
OTHER OWNED WORKS
WHOLESALERS & JOBBERS
$86,879,000
$83,964,000
HOUSEHOLD CONSUMER
RETAIL STORES
$532,000
$6,635,000




## DISTRIBUTION OF MANUFACTURERS' SALES OF CHEMICALS AND ALLIED

[1] Includes some purchased merchandise sold without processing.
[2] Includes some merchandise transferred to other plants in own organizations, excluded in computing expense ratio.
[3] Not shown separately to avoid disclosure of individual operations.
[4] Includes $1,220,000 received for services performed in processing materials for others.

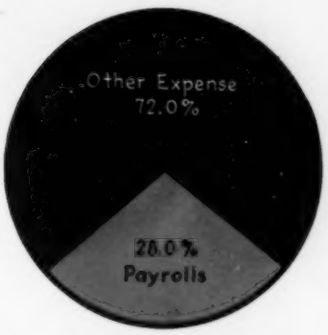
(Values in Thou,

SOURCE: CENSUS OF BUSINESS

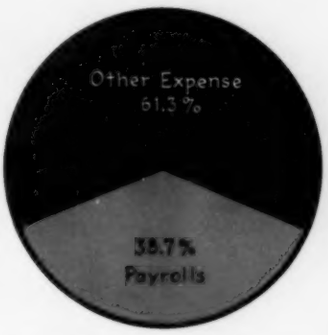
| Channels of Primary Distribution | Chemicals | Coke-Oven Products | Compressed and Liquefied Gases | Explosives | Fertilizers | Industrial and Household Chemical Compounds | Leather | Patent Medicines | Oil, Cake, and Meal Cottonseed |
|---|---|---|---|---|---|---|---|---|---|
| **Total Net Sales for Industry** | $623,674[1] | $188,639[1] | $52,025[1] | $42,841[1] | $154,108[1] | $58,748[1] | $308,899[1,4] | $292,681[1] | $193,051[1] |
| **Total Number of Plants** | 555 | 89 | 323 | 74 | 660 | 518 | 334[3] | 1,034 | 459 |
| To own wholesale branches | $203,249 | $43,303 | $15,535 | $32,033 | $20,682 | $7,122 | $52,804 | $73,826 | $3,275 |
| Per cent of total sales | 32.6 | 22.9 | 29.9 | 74.9 | 13.4 | 12.1 | 17.1 | 25.2 | 1.7 |
| Number of plants selling | 65 | 18 | 139 | 39 | 48 | 26 | 58 | 26 | 18 |
| To industrial and other large users | $216,591 | $41,983 | $27,341 | $4,799 | $18,228 | $21,919 | $154,194 | $16,212 | $73,881 |
| Per cent of total sales | 34.7 | 22.3 | 52.5 | 11.2 | 11.8 | 37.2 | 49.8 | 5.5 | 38.3 |
| Number of plants selling | 161 | 56 | 122 | 26 | 31 | 262 | 229 | 42. | 262 |
| To wholesalers and jobbers | $83,964 | $19,725 | $1,598 | $1,177 | $19,496 | $15,648 | $40,113 | $106,828 | $57,170 |
| Per cent of total sales | 13.5 | 10.5 | 3.1 | 2.7 | 12.7 | 26.6 | 13.0 | 36.6 | 29.6 |
| Number of plants selling | 53 | 33 | 33 | 10 | 37 | 230 | 119 | 282 | 288 |
| To own retail stores | ..... | ..... | ..... | ..... | $1,609 | $221 | ..... | $1,535 | |
| Per cent of total sales | ..... | ..... | ..... | ..... | 1.0 | 0.4 | ..... | 0.5 | (3) |
| Number of plants selling | ..... | ..... | ..... | ..... | 8 | 8 | ..... | 8 | |
| To retailers (including chain stores) | $6,635 | $10,230 | $330 | $230 | $57,459 | $5,273 | $1,730 | $69,206 | $16,616 |
| Per cent of total sales | 1.1 | 5.4 | 0.6 | 0.5 | 37.4 | 9.0 | 0.6 | 23.6 | 8.6 |
| Number of plants selling | 8 | 13 | 18 | 6 | 78 | 166 | 20 | 118 | 239 |
| To household consumers | $532 | $5,790 | ..... | ..... | $23,165 | $916 | ..... | $6,078 | $10,833 |
| Per cent of total sales | 0.1 | 3.1 | ..... | ..... | 15.0 | 1.6 | ..... | 2.1 | 5.6 |
| Number of plants selling | 1 | 23 | ..... | ..... | 135 | 72 | ..... | 55 | 242 |
| **Total Distributed Sales** | $510,971 | $121,031 | $44,804 | $38,239 | $140,639 | $51,099 | $248,841 | $273,685 | $161,775 |
| Transfer to other plants in same organization | $86,879 | $67,608 | $7,221 | $4,602 | $6,216 | $3,849 | $48,065 | $11,663 | $22,890 |
| Per cent of total sales | 13.9 | 35.8 | 13.9 | 10.7 | 4.0 | 6.6 | 15.6 | 4.0 | 11.9 |
| Number of plants selling | 26 | 40 | 66 | 17 | 4 | 20 | 46 | 8 | 133 |
| Sales not allocated to usual channels | $25,824 | ..... | ..... | ..... | $7,253 | $3,800 | $11,993 | $7,333 | $8,386 |
| Per cent of total sales | 4.1 | ..... | ..... | ..... | 4.7 | 6.5 | 3.9 | 2.5 | 4.3 |
| Number of plants | 4 | ..... | ..... | ..... | 34 | 33 | 32 | 18 | 40 |
| Sales negotiated through agents, brokers, and commission houses (incl. above) | $44,755 | $25,453 | $1,710 | (3) | $36,885 | $4,200 | $43,974 | $19,004 | $55,009 |
| Per cent of total sales | 7.2 | 13.5 | 3.3 | | 23.9 | 7.1 | 14.2 | 6.5 | 28.5 |
| Number of plants using | 19 | 41 | 13 | | 39 | 90 | 96 | 18 | 210 |
| **Distribution Expenses of Plants Reporting in Full** | | | | | | | | | |
| Number of plants reporting | 261 | 23 | 85 | 16 | 431 | 221 | 127 | 761 | 159 |
| Total net sales | $197,555 | $61,409[2] | $24,734[2] | $6,449 | $117,720 | $26,445[2] | $128,074[2] | $239,004 | $82,483[2] |
| Total expenses | $14,907 | $2,705 | $3,740 | $762 | $12,493 | $6,407 | $8,745 | $46,200 | $3,049 |
| Per cent of net sales | ..... | 4.8 | 15.2 | 12.2 | ..... | 24.3 | 6.9 | ..... | 4.3 |
| Pay roll | $4,172 | $1,267 | $1,214 | $344 | $4,890 | $3,120 | $2,994 | $15,429 | $1,262 |
| Other expenses | $10,795 | $1,438 | $2,526 | $418 | $7,603 | $3,287 | $5,751 | $30,771 | $1,787 |
| **Total Reported Distribution Employees and Payroll** | | | | | | | | | |
| Number of plants reporting | 261 | 30 | 101 | 23 | 431 | 345 | 215 | 761 | 293 |
| Total employees | 1,587 | 886 | 513 | 133 | 2,740 | 1,925 | 1,560 | 8,365 | 1,173 |
| Male | 1,222 | 802 | 481 | 124 | 2,458 | 1,647 | 1,319 | 5,912 | 1,115 |
| Female | 365 | 84 | 32 | 9 | 282 | 278 | 241 | 2,453 | 58 |
| Total pay roll | $4,172 | $1,289 | $1,256 | $367 | $4,890 | $3,516 | $3,457 | $15,429 | $1,485 |

| FOR COMPARISON | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Per cent of Distributed Sales to:** | | | | | | | | | | | | | | | | | | |
| Own wholesale branches | 39.8 | No comparable information | 35.7 | No comparable information | 34.7 | No comparable information | 83.7 | No comparable information | 14.7 | No comparable information | 13.9 | No comparable information | 21.2 | 19.8 | 27.0 | 18.7 | 2.0 | 4.5 |
| Industrial users | 42.4 | | 34.7 | | 61.0 | | 12.6 | | 13.0 | | 43.0 | | 62.0 | 47.6 | 5.9 | 8.7 | 45.7 | 43.8 |
| Wholesalers and jobbers | 16.4 | | 16.3 | | 3.6 | | 3.1 | | 13.9 | | 30.6 | | 16.1 | 32.6 | 39.0 | 15.7 | 35.3 | 45.1 |
| Own retail stores | .... | | .... | | .... | | .... | | 1.1 | | 0.4 | | .... | (5) | 0.6 | 0.6 | .... | 0.7 |
| Retailers | 1.3 | | 8.5 | | 0.7 | | 0.6 | | 40.8 | | 10.3 | | 0.7 | (5) | 25.3 | 15.7 | 10.3 | 5.9 |
| Household consumers | 0.1 | | 4.8 | | .... | | .... | | 16.5 | | 1.8 | | .... | .... | 2.2 | 4.6 | 6.7 | (7) |

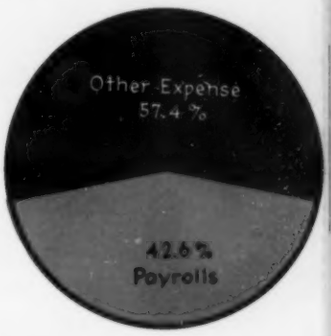
PAYROLLS ARE LESS IMPORTANT THAN OTHER EXPENSES IN CHEMICAL DISTRIBUTION.




Sales Expense Dollar for the Chemical Manufacturer




Sales Expense Dollar for the Process Industries




Sales Expense Dollar for All Industries

## PRODUCTS, 1935, SHOWING SALES FROM PLANTS AND DISTRIBUTION EXPENSES

sands of Dollars)

U. S. DEPARTMENT OF COMMERCE

[5] In addition, 50 plants made no sales but recieved $4,758,000 for processing materials owned by others.
[6] Sales were combined with sales to wholesalers and jobbers, and to own wholesale branches because of incomplete reports.
[7] In 1929 sales to household consumers were combined with sales to industrial users on account of incomplete reports.

| Oil, Cake, and Meal Linseed | Paints, Pigments and Varnishes | Petroleum Refining | Pulp | Rayon | Salt | Soap | Tanning Materials | Wood Distillation, etc. | Channels of Primary Distribution |
|---|---|---|---|---|---|---|---|---|---|
| $54,895 [1] | $426,352 [1] | $1,906,310 [1] | $164,100 [1] | $185,724 [1] | $33,064 [1] | $238,063 [1] | $35,954 [1] | $17,172 [1] | **Total Net Sales for Industry** |
| 24 | 1,063 | 390 | 187 | 32 | 46 | 232 | 142 | 61 | **Total Number of Plants** |
| $5,112 | $137,669 | $1,071,122 | $4,684 | $82,665 | $16,719 | $179,030 | $1,742 | $7,940 | To own wholesale branches |
| 9.3 | 32.3 | 56.2 | 2.9 | 44.5 | 50.6 | 75.1 | 4.8 | 46.3 | Per cent of total sales |
| 7 | 51 | 56 | 6 | 10 | 19 | 34 | 8 | 11 | Number of plants selling |
| $19,124 | $129,317 | $165,688 | $43,051 | $97,592 | $5,102 | $15,139 | $29,019 | $4,289 | To industrial and other large users |
| 34.8 | 30.4 | 8.7 | 26.2 | 52.9 | 15.4 | 6.4 | 80.8 | 25.0 | Per cent of total sales |
| 11 | 211 | 11 | 67 | 13 | 26 | 124 | 125 | 35 | Number of plants selling |
| $27,254 | $49,967 | $324,746 | $2,584 | $1,604 | $7,191 | $20,608 | $2,743 | $3,546 | To wholesalers and jobbers |
| 49.7 | 11.7 | 17.0 | 1.6 | 0.9 | 21.7 | 8.7 | 7.6 | 20.6 | Per cent of total sales |
| 16 | 79 | 55 | 6 | ..... | 26 | 138 | 32 | 28 | Number of plants selling |
| ([3]) | $12,369 | $72,498 | ..... | ..... | ..... | ..... | ..... | ..... | To own retail stores |
| ..... | 2.9 | 3.8 | ..... | ..... | ..... | ..... | ..... | ..... | Per cent of total sales |
| ..... | 18 | 1 | ..... | ..... | ..... | ..... | ..... | ..... | Number of plants selling |
| $2,602 | $59,237 | $24,352 | ..... | ..... | $1,780 | $17,087 | ([3]) | $226 | To retailers (including chain stores) |
| 4.7 | 13.9 | 1.3 | ..... | ..... | 5.4 | 7.2 | | 1.3 | Per cent of total sales |
| 5 | 66 | 12 | ..... | ..... | 14 | 83 | | 7 | Number of plants selling |
| ..... | $4,886 | $1,750 | ..... | ..... | $91 | $821 | ([3]) | ([3]) | To household consumers |
| ..... | 1.1 | 0.1 | ..... | ..... | 0.3 | 0.3 | | | Per cent of total sales |
| ..... | 19 | 5 | ..... | ..... | 5 | 22 | | | Number of plants selling |
| $54,092 | $393,445 | $1,660,156 | $50,319 | $181,861 | $30,883 | $232,685 | $33,504 | $16,001 | **Total Distributed Sales** |
| ([3]) | $22,627 | $135,412 | $105,990 | $3,749 | $86 | $4,451 | $1,772 | $1,171 | Transfer to other plants in same organization |
| | 5.3 | 7.1 | 64.6 | 2.0 | 0.3 | 1.9 | 4.9 | 6.8 | Per cent of total sales |
| | 17 | 10 | 154 | ..... | 4 | 9 | 14 | 11 | Number of plants selling |
| $803 | $10,280 | $110,742 | $7,791 | $114 | $2,095 | $927 | $678 | ([3]) | Sales not allocated to usual channels |
| 1.5 | 2.4 | 5.8 | 4.7 | 0.1 | 6.3 | 0.4 | 1.9 | | Per cent of total sales |
| 3 | 30 | 4 | 9 | ..... | 6 | 14 | 19 | | Number of plants |
| $10,907 | $16,118 | $21,099 | $8,306 | $7,079 | $2,775 | $10,670 | $1,853 | $7,388 | Sales negotiated through agent, brokers, and commission houses (incl. above) |
| 19.9 | 3.8 | 1.1 | 5.1 | 3.8 | 8.4 | 4.5 | 5.2 | 43.0 | Per cent of total sales |
| 8 | 9 | 1 | 15 | 3 | 13 | 45 | 23 | 33 | Number of plants using |
| 6 | 827 | 180 | 9 | 13 | 16 | 116 | 67 | 9 | **Distribution Expenses of Plants Reporting in Full** Number of plants reporting |
| $6,123 | $261,479 | $455,245 | $24,029 [2] | $42,729 | $8,514 [2] | $60,350 [2] | $22,274 [2] | $4,003 [2] | Total net sales |
| $250 | $39,051 | $14,703 | $577 | $1,824 | $2,217 | $11,095 | $3,109 | $221 | Total expenses |
| 4.1 | ..... | ..... | 2.7 | ..... | 26.0 | 19.6 | 14.8 | 6.9 | Per cent of net sales |
| $79 | 19,206 | 3,895 | $197 | 411 | $842 | $3,405 | $1,506 | $129 | Pay roll |
| $171 | 19,845 | $10,808 | $380 | $1,413 | $1,375 | $7,690 | $1,603 | $92 | Other expenses |
| 9 | 827 | 180 | 18 | 13 | 25 | 163 | 97 | 26 | **Total Reported Distribution Employees and Pay Roll** Number of plants reporting |
| 31 | 7,888 | 2,220 | 75 | 125 | 490 | 1,679 | 438 | 74 | Total employees |
| 25 | 6,490 | 2,010 | 58 | 91 | 433 | 1,383 | 341 | 62 | Male |
| 6 | 1,398 | 210 | 17 | 34 | 57 | 296 | 97 | 12 | Female |
| $79 | $19,206 | $3,895 | $244 | $411 | $993 | $3,460 | $1,563 | $152 | Total pay roll |

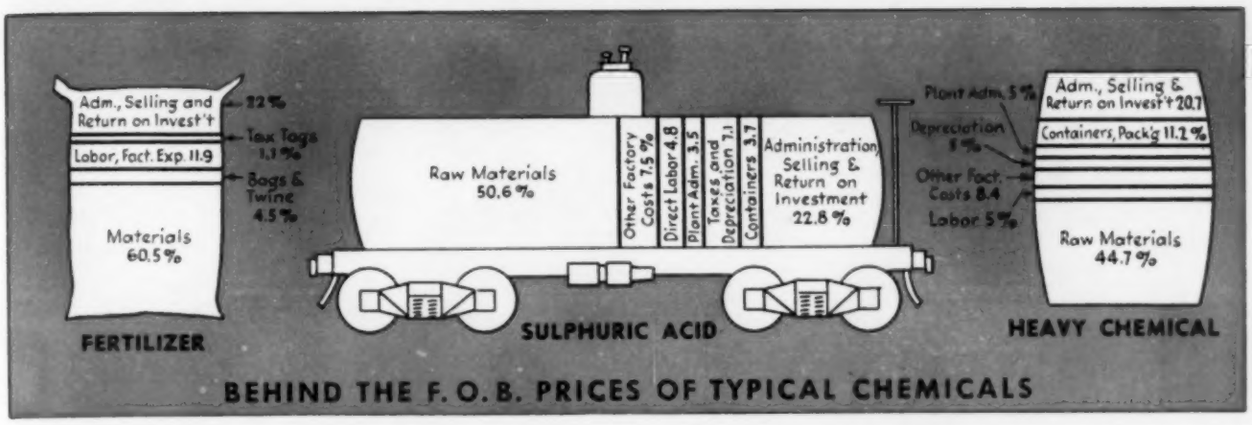
| 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | 1935 | 1929 | FOR COMPARISON |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.5 | 6.4 | 35.0 | | 64.4 | 60.3 | 9.3 | .... | 45.5 | 36.0 | 54.1 | | 76.9 | | 5.2 | | 49.6 | | **Per cent of Distributed Sales to:** Own wholesale branches |
| 35.4 | 44.9 | 32.9 | | 10.0 | 8.6 | 85.6 | 99.4 | 53.6 | 64.0 | 16.5 | | 6.5 | | 86.6 | | 26.8 | | Industrial users |
| 50.3 | 46.6 | 12.7 | | 19.6 | 18.3 | 5.1 | 0.6 | 0.9 | .... | 23.3 | | 8.9 | | 8.2 | | 22.2 | | Wholesalers and jobbers |
| .... | .... | 3.1 | | 4.4 | 7.6 | .... | .... | .... | .... | .... | | .... | | .... | | .... | | Own retail stores |
| 4.8 | 2.1 | 15.1 | | 1.5 | 5.2 | .... | .... | .... | .... | 5.8 | | 7.3 | | .... | | 1.4 | | Retailers |
| .... | .... | 1.2 | | 0.1 | .... | .... | .... | .... | .... | 0.3 | | 0.4 | | .... | | .... | | Household consumers |
| | | | No comparable information | | | | | | | | No comparable information | | No comparable information | | No comparable information | | No comparable information | |

# PRICE TRENDS IN AMERICAN CHEMICAL INDUSTRY

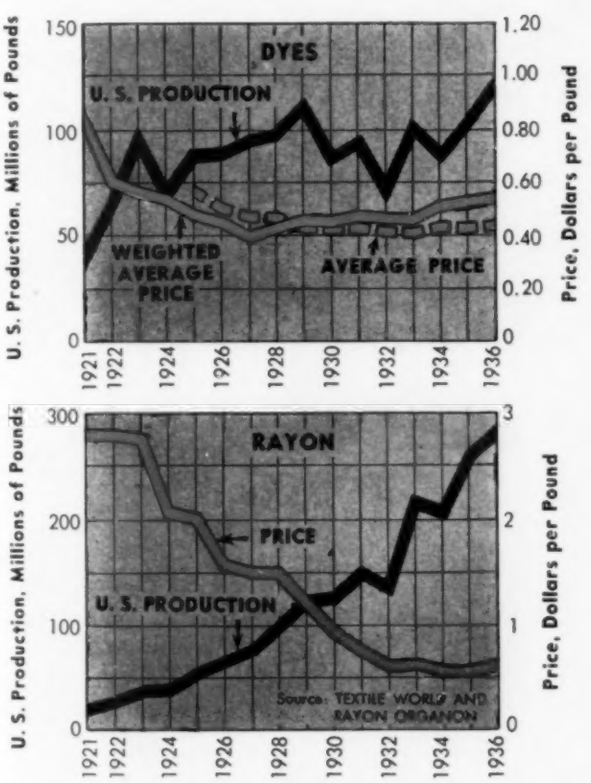
PRICES OF CHEMICALS are more stable than those for many other industrial goods, and far more stable than prices for farm products, foods and most consumer's goods. This stability in price is one of the great contributions made by American chemical industry to the industrial stability of its customers. Users of industrial chemicals are often more interested in certainty as to future prices of their chemical raw materials than they might be in minor price cuts, if the latter had to be followed at some early, but uncertain, date by unexpected and perhaps large increases.

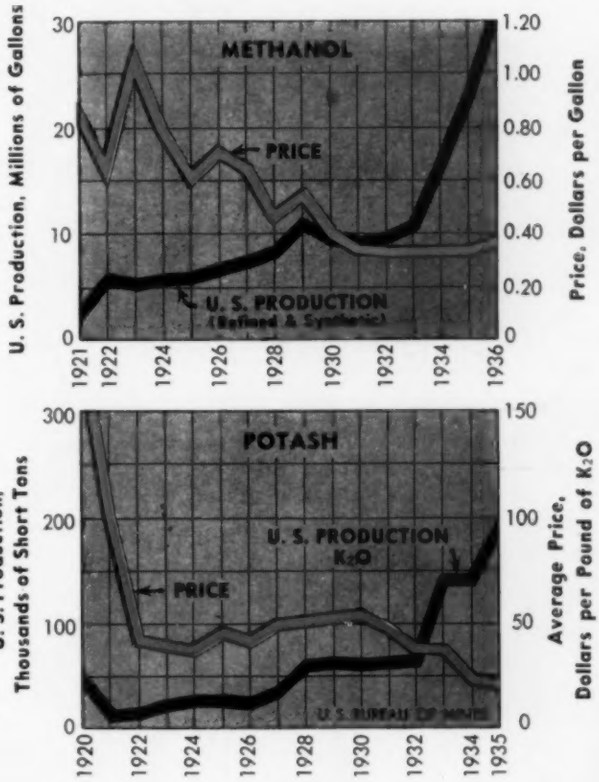
Prices of chemicals have trended downward over a period of years. This is in spite of the fact that the costs of labor and capital required in the manufacture of chemicals have been increasing. Skilled management, with the aid of research, has been able to offset these "rising rents" for manhours and money largely by improving efficiency in both production and distribution.

Lower costs which come with greater usage have also been shared by the producer with his customers because chemical industry believes and practices the gospel of the research laboratory: More goods at lower prices! This is especially true of new industries, of which chemical research has provided many. The result has been a lowering of the costs of many commodities, for as these trends are continued, they afford benefits not only to the direct customers of chemical industry but also to the general public, which ultimately pays all the bills.




## THE PRICE DROPS AS PRODUCTION RISES

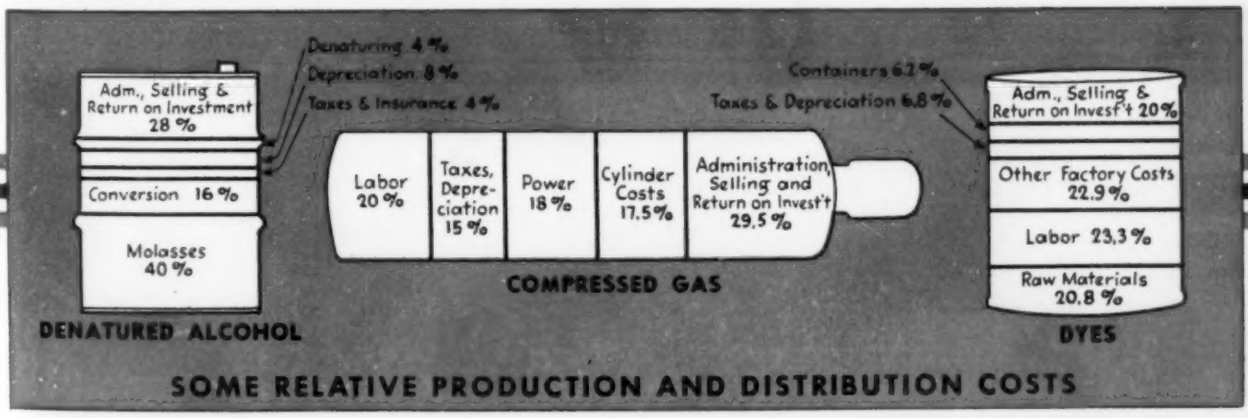


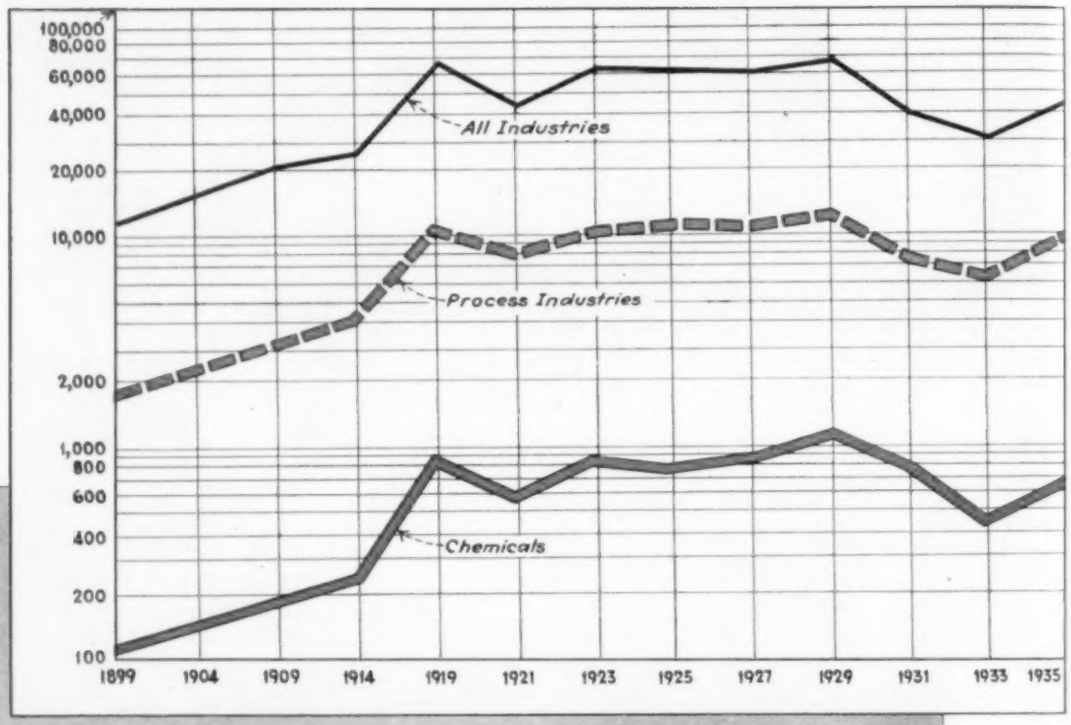







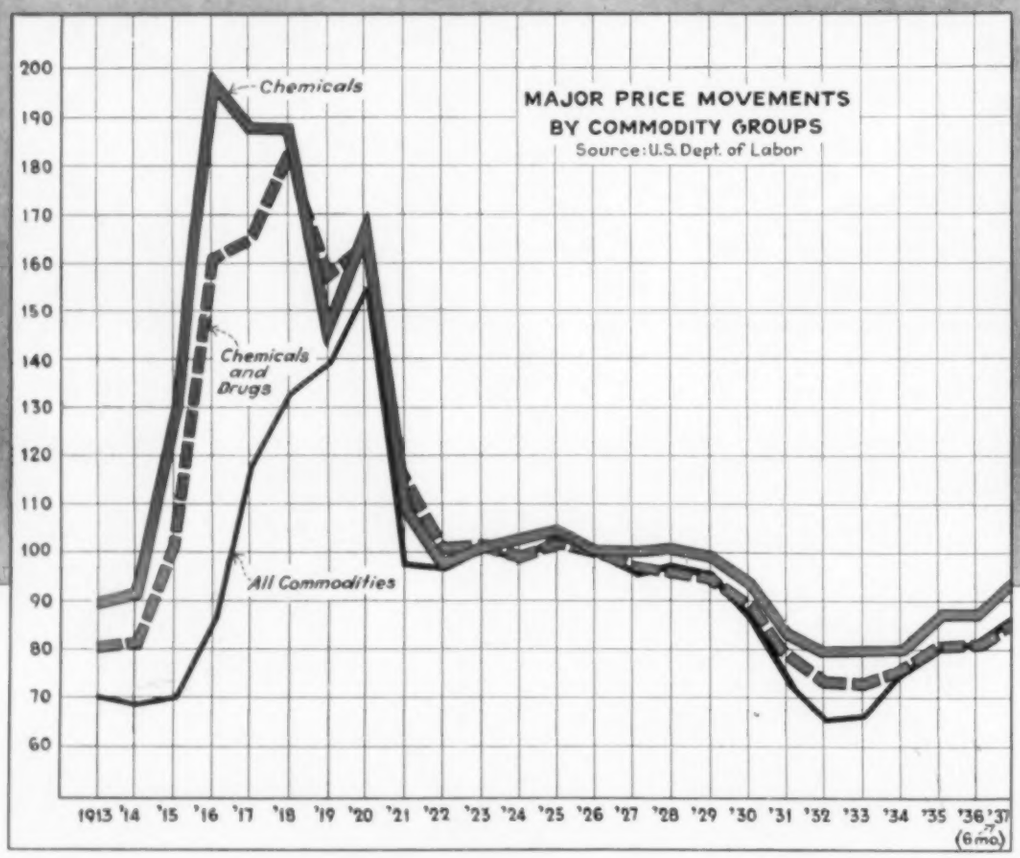


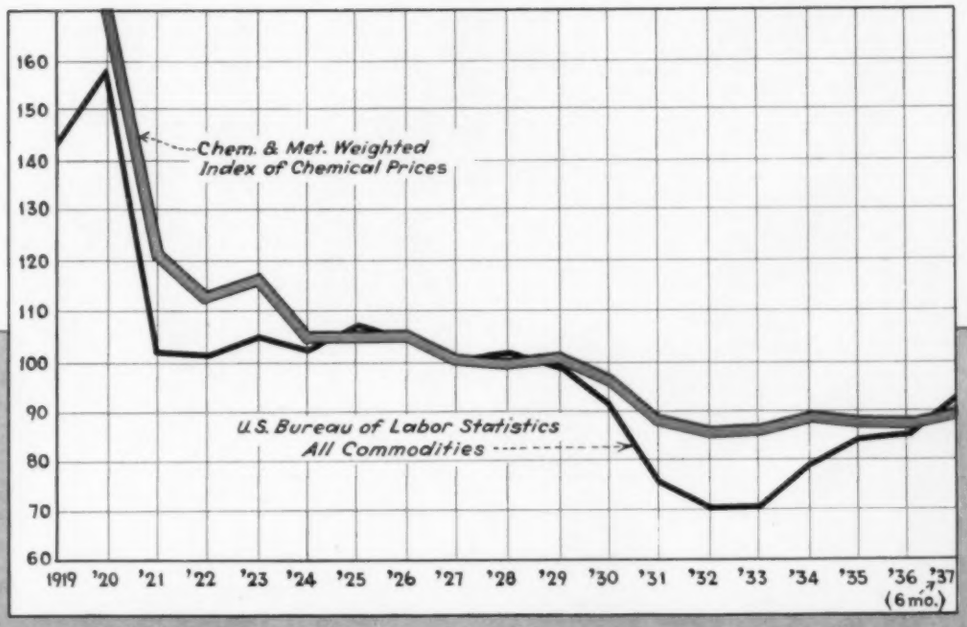






Production
In Millions
Of Dollars

# TRENDS IN PRICES AND PRODUCTION



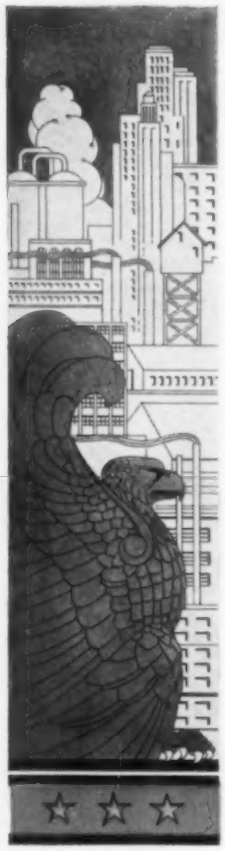



**Chemical Prices Are More Stable Than for All Commodities**

# PRICE HISTORY OF MAJOR CHEMICALS

## TEN-YEAR PRICE TRENDS FOR THIRTY BASIC CHEMICALS

| Commodities and Units of Sale | (7 Mos.) 1937 | 1936 | 1935 | 1934 | 1933 | 1932 | 1931 | 1930 | 1929 | 1928 | 1927 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acetic Acid, 28%, bbl., 100 lb | $2.43 | $2.45 | $2.43 | $2.75 | $2.79 | $2.61½ | $2.56 | $3.39 | $3.88 | $3.53 | $3.38 |
| Muriatic Acid, 18°, tanks, 100 lb | 1.01 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | .85 | .85 |
| Nitric Acid, 36°, carboys, 100 lb | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Sulphuric Acid, 60°, tanks, ton | 11.14 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 11.00 | 10.50 |
| Alcohol Denatured, S. D. No. 1 Gal | .33 | .33½ | .36 | .34 | .34 | .31½ | .30½ | .43 | .49½ | .46 | .42 |
| Methanol, Crude, tanks, Gal | .33 | .37 | .33 | .33 | .33 | .33 | .343 | .393 | .544 | .44 | .67½ |
| Aluminum Sulphate, bags, 100 lb | 1.35 | 1.35 | 1.35 | 1.35 | 1.25 | 1.25 | 1.27½ | 1.40 | 1.40 | 1.40 | 1.40 |
| Ammonia Anhydrous, cyl., lb | .156 | .15½ | .15½ | .15½ | .15½ | .15½ | .15½ | .15 | .14 | .13½ | .11 |
| Ammonium Sulphate, 100 lb | 1.37 | 1.248 | 1.20 | 1.23 | 1.12 | 1.04 | 1.50 | 1.75 | 2.20 | 2.43 | 2.38 |
| Aniline Oil, drums, lb | .15 | .14½ | .14½ | .14½ | .14½ | .14½ | .14½ | .15 | .14½ | .15 | .15 |
| Arsenic, White, pwd., lb | .03 | .03½ | .03½ | .038 | .04 | .04 | .04 | .04 | .04 | .04 | .036 |
| Benzol, 90% tanks, Gal | .16 | .173 | .15½ | .193 | .21½ | .20 | .19½ | .21½ | .23 | .22 | .24 |
| Borax, gran. ton | 40.67 | 44.00 | 42.00 | 40.00 | 40.00 | 42.25 | 60.00 | 66.00 | 53.00 | 62.67 | 90.00 |
| Calcium Carbide, drums, lb | .05 | .05 | .05 | .05 | .05 | .05 | .05 | .05 | .05 | .05 | .052 |
| Carbon Bisulphide, drums, lb | .05 | .05½ | .05½ | .05½ | .05½ | .05 | .05 | .05 | .05 | .05 | .05½ |
| Chlorine, liquid, tanks, 100 lb | 2.15 | 2.15 | 2.02½ | 1.85 | 1.76¾ | 1.70 | 1.75 | 2.50 | 2.90 | 3.45 | 4.00 |
| Ethyl Acetate, drums, lb | .07 | .073 | .08½ | .08½ | .086 | .10 | .072 | .10 | .15 | .11 | .12½ |
| Formaldehyde, 40% bbl., lb | .05¾ | .059 | .06 | .06 | .06 | .06 | .06 | .07 | .09 | .08½ | .10½ |
| Lithopone, bags, 100 lb | 4.26 | 4.60 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 5.25 | 5.50 | 5.50 | 5.50 |
| Phenol, U. S. P., drums, lb | .13½ | .142 | .143 | .14½ | .14½ | .14½ | .14½ | .14¾ | .13½ | .157 | .17½ |
| Salt Cake, bulk ton | 13.00 | 13.00 | 13.00 | 13.00 | 13.00 | 14.25 | 15.00 | 17.50 | 17.00 | 15.00 | 17.00 |
| Soda Ash, light, 58% bags, 100 lb | 1.25 | 1.23 | 1.23 | 1.23 | 1.20½ | 1.15 | 1.15 | 1.32 | 1.32 | 1.32 | 1.32 |
| Caustic Soda, 76% Solid, drums, 100 lb | 2.60 | 2.60 | 2.60 | 2.60 | 2.51¾ | 2.50 | 2.50 | 2.90 | 2.70 | 2.80 | 3.00 |
| Sodium Bichromate, casks, lb | .06¾ | .06¾ | .059 | .05¾ | .048 | .05 | .06¾ | .07 | .07 | .068 | .06¾ |
| Sodium Phosphate, Tri-Basic, bbl., 100 lb | 2.10 | 2.00 | 2.00 | 2.10 | 2.15 | 2.60 | 3.06 | 3.37½ | 3.30 | 3.50 | 3.50 |
| Sodium Silicate, 40° drums, 100 lb | .80 | .80 | .80 | .60 | .60 | .65 | .60 | .60 | .75 | .75 | .75 |
| Sulphur, Crude, long ton | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 19.00 |
| Turpentine, bbl., gal | .48¾ | .53¾ | .50½ | .43¾ | .46½ | .42 | .46½ | .48 | .57½ | .57 | .63 |
| White Lead, dry, casks, 100 lb | 7.50 | 6.52 | 6.50 | 6.44 | 6.30 | 6.50 | 7.25 | 7.96 | 8.85 | 8.50 | 9.31 |
| Zinc Oxide, lead free, bags, 100 lb | 5.71 | 5.06 | 5.66 | 6.30 | 5.75 | 5.90 | 6.62½ | 6.62½ | 6.62½ | 6.62½ | 6.62½ |

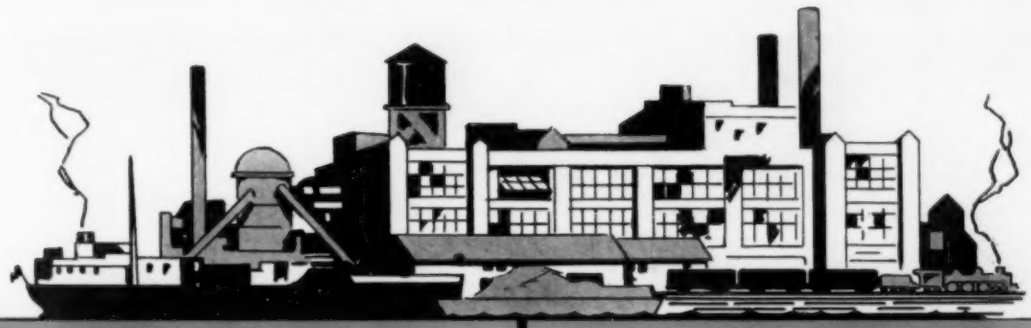


# TRANSPORTATION AND CONTAINERS FOR CHEMICAL INDUSTRY

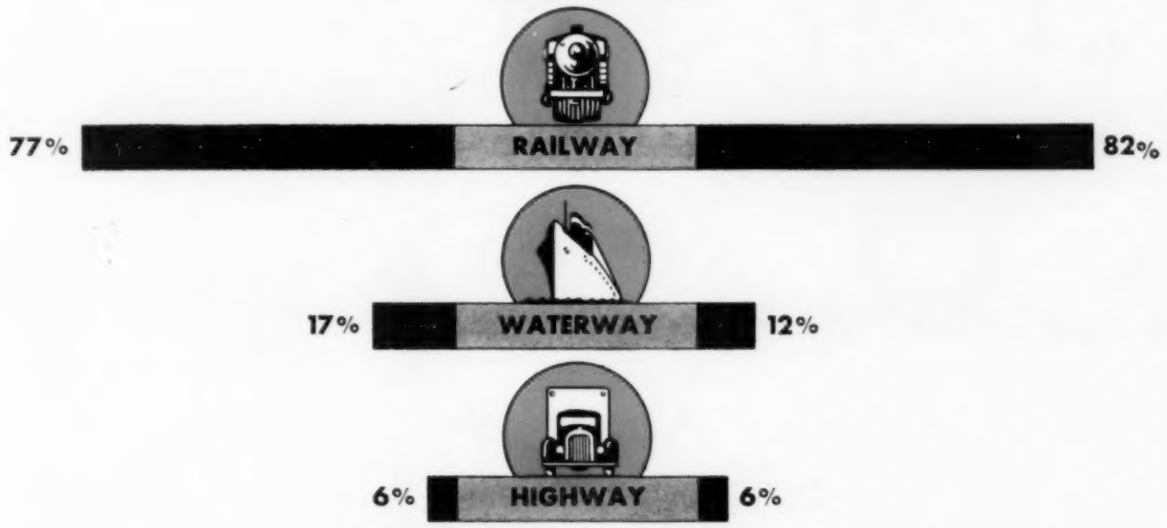
TRANSPORTATION of chemicals involves many special problems. Some of these goods, by their very nature, are difficult to package and potentially dangerous to handle. But the American chemical industry has made as serious a study of packaging and transportation, as it has of manufacture and marketing. The results are adequate, safe, effective containers for each special type of goods.

Chemicals pay a substantial part of the total freight bill of America. But they are responsible for an even larger percentage of the total freight hauled by rail, by road, and by water. Raw materials and finished products of chemical process industries are, in fact, among the most important industrial commodities. They probably are a close third to the products of agriculture and the products of mining in their total tonnage of freight.

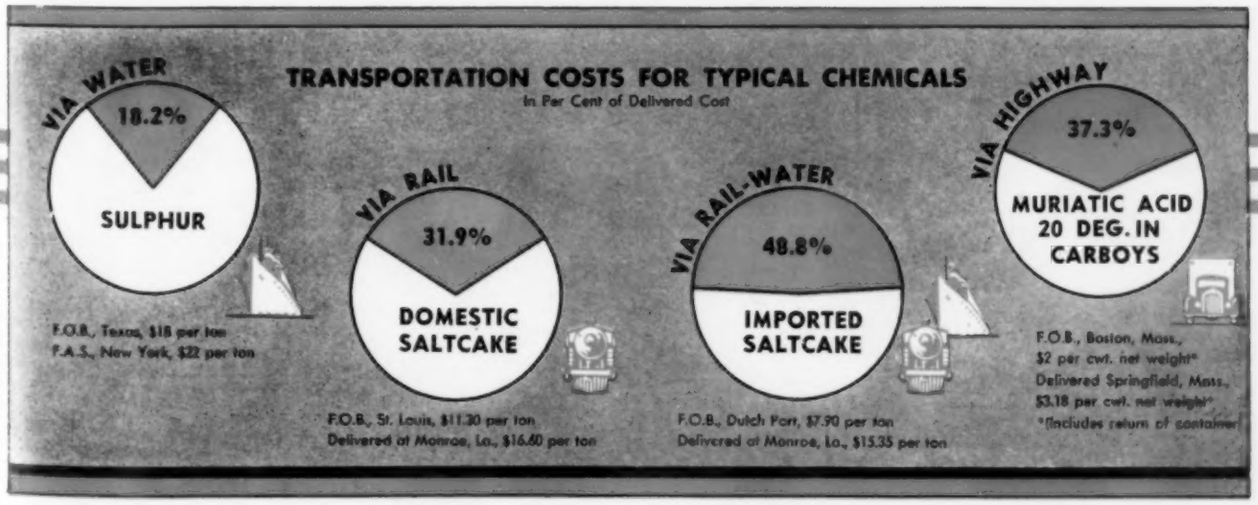
Containers add considerable to the cost of chemicals and in addition the industry has approximately $200,000,000 invested in tank cars, tankers, cylinders, carboys and returnable drums. But the investment in money is far less important than the investments in skill and carefulness. These latter represent the basis for safe handling after production, during transportation and in the user's plant. And, in the last analysis, the consumer wants safe as well as economic delivery of his goods.



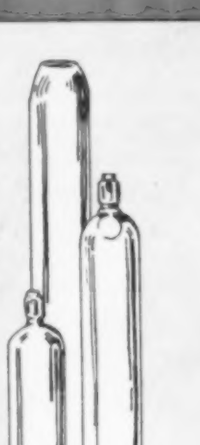
| INBOUND SHIPMENTS | | OUTBOUND SHIPMENTS | |
|---|---|---|---|
| SOLID FUELS AND RAW MATERIALS | 230,000,000 TONS | SOLID PRODUCTS | 180,000,000 TONS |
| LIQUID FUELS AND RAW MATERIALS | 175,000,000 TONS | LIQUID PRODUCTS | 125,000,000 TONS |
| | | GASEOUS PRODUCTS | 1,000,000 TONS |




At an estimated cost to chemical industries of $1,000,000,000 for transportation and $500,000,000 invested in shipping facilities and spent annually for packing and containers.

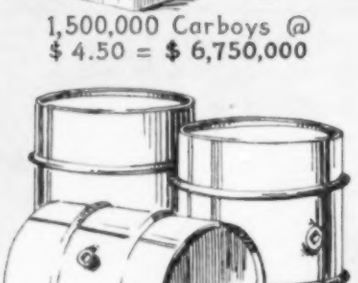

TRANSPORTATION COSTS FOR TYPICAL CHEMICALS
In Per Cent of Delivered Cost
VIA WATER
18.2%
SULPHUR
F.O.B., Texas, $18 per ton
F.A.S., New York, $22 per ton
VIA RAIL
31.9%
DOMESTIC SALTCAKE
F.O.B., St. Louis, $11.30 per ton
Delivered at Monroe, La., $16.60 per ton
VIA RAIL-WATER
48.8%
IMPORTED SALTCAKE
F.O.B., Dutch Port, $7.90 per ton
Delivered at Monroe, La., $15.35 per ton
VIA HIGHWAY
37.3%
MURIATIC ACID 20 DEG. IN CARBOYS
F.O.B., Boston, Mass., $2 per cwt. net weight*
Delivered Springfield, Mass., $3.18 per cwt. net weight*
*Includes return of container

# CHEMICAL INDUSTRY HAS INVESTED $200,000,000 IN TANK CARS AND RETURNABLE CONTAINERS



5,000,000 Cylinders @ $11 = $55,000,000

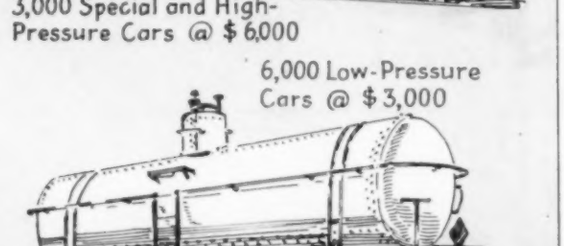
1,500,000 Carboys @ $4.50 = $6,750,000



15,000,000 Returnable Drums @ $7 = $105,000,000

3,000 Special and High-Pressure Cars @ $6,000

6,000 Low-Pressure Cars @ $3,000



Total Investment $ 36,000,000

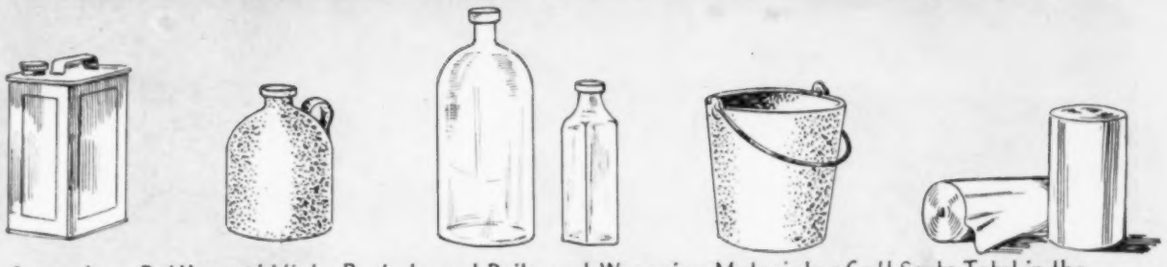
## FREIGHT CHARGES IN THE UNITED STATES FOR CHEMCAL COMMODITIES HANDLED DURING 1935 BY PRINCIPAL RAILROADS.

Data from Official Records of Interstate Commerce Commission.

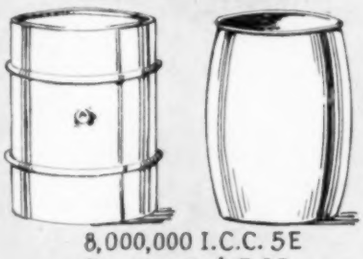
| | Number of Carloads | Number of Tons | Ave. No. of Tons per Car | Freight Charge (Millions of Dollars) |
|---|---|---|---|---|
| Sulphuric acid | 50,000 | 2,440,000 | 49.38 | $4.07 |
| Alcohol, denatured or wood | 34,000 | 720,000 | 21.64 | 2.52 |
| Explosives, N. O. S. | 25,000 | 410,000 | 16.24 | 2.58 |
| Petroleum oils, refined and all other gasolines | 2,328,000 | 64,880,000 | 28.20 | 168.45 |
| Fuel, road and petroleum residual oils | 517,000 | 16,880,000 | 33.25 | 32.90 |
| Lubricating oils and greases | 283,000 | 6,270,000 | 22.34 | 18.17 |
| Petroleum products, N. O. S. | 20,000 | 440,000 | 22.69 | 1.32 |
| Cottonseed oil | 58,000 | 1,610,000 | 28.21 | 5.04 |
| Linseed oil | 14,000 | 360,000 | 27.03 | 1.06 |
| Vegetable oil | 44,000 | 1,320,000 | 30.04 | 4.14 |
| Sugar (beet or cane) | 233,000 | 7,480,000 | 33.03 | 22.30 |
| Table syrup and edible molasses | 41,000 | 1,300,000 | 31.89 | 4.01 |
| Molasses, blackstrap, and beet residual | 25,000 | 1,180,000 | 47.40 | 2.52 |
| Aluminum: Ingot, pig, or slab | 4,000 | 130,000 | 28.57 | .44 |
| Cement, natural or Portland (bldg.) | 591,000 | 20,630,000 | 35.32 | 31.48 |
| Brick, common | 56,000 | 2,020,000 | 36.02 | 2.35 |
| Brick N. O. S. and bldg. tile | 161,000 | 5,800,000 | 36.78 | 9.56 |
| Artificial stone N. O. S. | 8,000 | 230,000 | 29.72 | .41 |
| Lime, common (quick or slaked) | 122,000 | 3,020,000 | 24.71 | 4.78 |
| Plaster (stucco or wall) and dry kalsomine | 69,000 | 1,670,000 | 24.15 | 3.53 |
| Sewer pipe and draintile (not metal) | 82,000 | 1,410,000 | 17.09 | 3.05 |
| Fertilizers, N. O. S. | 408,000 | 11,610,000 | 27.65 | 21.67 |
| Newsprint paper | 228,000 | 6,040,000 | 26.08 | 12.38 |
| Printing paper | 151,000 | 3,450,000 | 22.47 | 8.75 |
| Tobacco, manufactured products | 32,000 | 640,000 | 19.38 | 4.12 |

| | Number of Carloads | Number of Tons | Ave. No. of Tons per Car | Freight Charge (Millions of Dollars) |
|---|---|---|---|---|
| Paints in oil and varnishes | 28,000 | 650,000 | 22.09 | 2.73 |
| Paperboard, pulpboard, and wallboard (paper) | 218,000 | 4,660,000 | 21.22 | 11.64 |
| Building paper and prepared roofing materials | 141,000 | 3,170,000 | 22.27 | 8.48 |
| Soap and washing compounds | 87,000 | 1,870,000 | 21.62 | 5.80 |
| Glass, flat, other than plate | 29,000 | 890,000 | 32.18 | 3.10 |
| Glass: bottles, jars and jelly glasses | 212,000 | 3,710,000 | 17.64 | 11.13 |
| Cotton linters | 48,000 | 890,000 | 18.24 | 2.41 |
| Cottonseed | 39,000 | 1,020,000 | 26.71 | 1.75 |
| Cottonseed meal and cake | 95,000 | 2,330,000 | 24.84 | 4.97 |
| Vegetable-oil cake and meal, except cottonseed | 29,000 | 740,000 | 24.89 | 1.56 |
| Flaxseed | 12,000 | 460,000 | 39.54 | 1.52 |
| Sugar beets | 115,000 | 5,210,000 | 45.64 | 2.94 |
| Hides, green | 70,000 | 1,700,000 | 24.28 | 6.11 |
| Leather | 24,000 | 450,000 | 18.30 | 1.52 |
| Fish or sea-animal oil | 15,000 | 440,000 | 30.01 | 1.30 |
| Coke | 482,000 | 16,120,000 | 34.12 | 19.18 |
| Petroleum, crude | 176,000 | 6,040,000 | 34.77 | 8.83 |
| Asphalt (natural, byproduct, or petroleum) | 157,000 | 5,560,000 | 35.54 | 10.70 |
| Salt | 230,000 | 7,000,000 | 30.84 | 13.89 |
| Phosphate rock, crude (ground or not ground) | 108,000 | 5,690,000 | 52.55 | 4.66 |
| Sulphur (brimstone) | 48,000 | 2,470,000 | 56.88 | 3.30 |
| Pulpwood | 248,000 | 7,700,000 | 33.07 | 6.58 |
| Rosin | 32,000 | 730,000 | 23.10 | 1.56 |
| Turpentine | 8,000 | 200,000 | 23.42 | .74 |
| Crude rubber (not reclaimed) | 25,000 | 840,000 | 34.17 | 2.66 |

# FOR THESE ONE-TRIP CONTAINERS, PROCESS INDUSTRY SPENDS ANNUALLY $250,000,000



Cans, Jugs, Bottles and Vials, Buckets and Pails, and Wrapping Materials of all Sorts Total in the Millions for Annual Sale to Process Industries

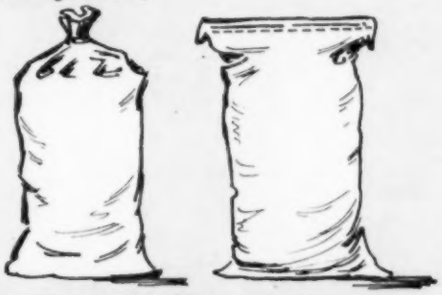


8,000,000 I.C.C. 5E Drums @ $ 3.25

10,000,000 Bbls. @ $1
4,000,000 Kegs @ 50¢

Wooden Boxes, Shooks and Packing Crates

500,000,000 Cloth Bags @ 8¢



500,000,000 Paper and Paper-Lined Bags @ 6¢

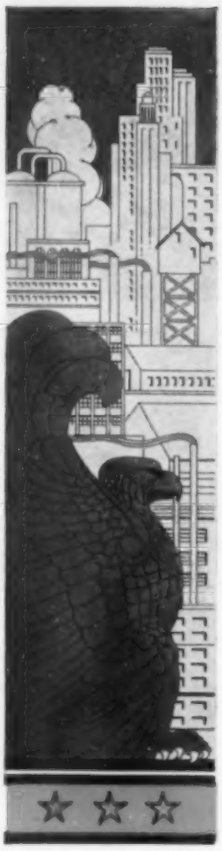
Fibre Drums

## FREIGHT CAR REQUIREMENTS FOR PRINCIPAL COMMODITIES, 1936-37.

(Data from Car Service Division of Association of American Railways)

| Commodity | Carloadings Actual 1936 | Estimated 1937 | Increase % |
|---|---|---|---|
| Grain, all | 334,801 | 379,077 | 13.2 |
| Flour, meal and other mill products | 204,797 | 202,859 | .9* |
| Hay, straw and alfalfa | 32,839 | 29,917 | 8.9* |
| Cotton | 65,378 | 72,001 | 10.1 |
| Cotton seed and products, except oil | 25,503 | 21,972 | 13.8* |
| Citrus fruits | 23,123 | 14,580 | 36.9* |
| Other fresh fruits | 99,121 | 104,984 | 5.9 |
| Potatoes | 35,487 | 38,499 | 8.5 |
| Other fresh vegetables | 37,717 | 38,806 | 2.9 |
| Live stock | 206,172 | 185,763 | 9.9* |
| Poultry and dairy products | 26,973 | 27,176 | .8 |
| Coal and coke | 1,701,867 | 1,762,552 | 3.6 |
| Ore and concentrates | 662,697 | 828,983 | 25.1 |
| Gravel, sand and stone | 440,935 | 456,066 | 3.4 |
| Salt | 28,642 | 29,415 | 2.7 |
| Lumber and forest products | 469,810 | 515,801 | 9.8 |
| Petroleum and petroleum products | 531,811 | 557,358 | 4.8 |
| Sugar, syrup and molasses | 38,781 | 39,935 | 3.0 |
| Iron and steel | 410,640 | 456,588 | 11.2 |
| Machinery and boilers | 37,909 | 41,816 | 10.3 |
| Cement | 161,802 | 195,172 | 20.6 |
| Brick and clay products | 74,264 | 80,432 | 8.3 |
| Lime and plaster | 37,508 | 41,037 | 9.4 |
| Agricultural implements and vehicles, other than automobiles | 14,752 | 17,806 | 20.7 |
| Automobiles, trucks and parts | 120,468 | 148,463 | 23.2 |
| Fertilizers, all kinds | 43,633 | 47,652 | 9.2 |
| Paper, paper board and prepared roofing | 84,887 | 94,579 | 11.4 |
| Chemicals and explosives | 27,059 | 28,785 | 6.4 |
| Canned goods — all canned food products (includes catsup, jams, jellies, olives, pickles, preserves, etc.) | 78,893 | 81,462 | 3.3 |
| Total all commodities listed | 6,058,269 | 6,539,536 | 7.9 |

* Decrease.



# AMERICAN CHEMICAL INDUSTRY AS A TAXPAYER

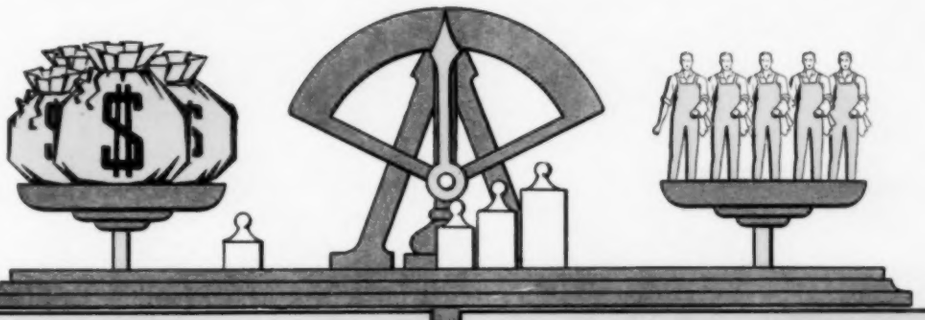
THE NATION'S tax bill is $12,500,000,000—roughly, equivalent to $100 per year for every person in the United States. Of this huge sum, $5,500,000,000 goes to the Federal government and $2,500,000,000 to the state governments while the share of the various local governments amounts to $4,500,000,000.

Where does all of this money come from? The largest source is property taxes, $4,500,000,000, closely followed by income taxes on individuals and corporations, which yield $2,600,000,000. Liquor and gasoline taxes each supply $800,000,000, tobacco taxes follow with $600,000,000, and the rapidly mounting payroll taxes have now reached $400,000,000. Customs, once our single most productive source of revenue, now yields only $400,000,000 and the many miscellaneous taxes—Federal, state and local—add up to $2,400,000,000.

Chemical process industries pay, of this total tax bill, at least $750,000,000 in direct taxes on property, income and operations, and in addition are responsible for the production of more than $2,000,000,000 arising from the sales taxes on gasoline and petroleum products and on alcoholic beverages, from extraction taxes on mineral raw materials such as sulphur, salt and crude oil, from processing taxes and special excise taxes on coconut and other vegetable oils, and for $40,000,000 of customs duty collected on imports of chemicals and chemical raw materials.

Chemical industry pays its share—and more—of the nation's tax bill!

## THE EQUIVALENT OF CHEMICAL TAXES IN PAYROLLS



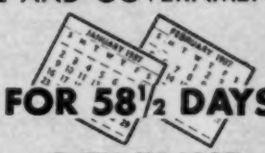
**$750,000,000**
**TAXES PAID BY PROCESS INDUSTRIES**

**FULL YEAR'S PAY FOR**
**610,000 WAGE EARNERS**

IN THE OLD DAYS TAXES WERE OFTEN PAID BY DIRECT MANUAL LABOR. IF THAT WERE TRUE TO-DAY IT WOULD REQUIRE A FULL YEAR'S WORK FROM 610,000 MEN MERELY TO PAY THE **DIRECT TAXES** ON CHEMICAL PROCESS INDUSTRIES. CONVERSELY, THE CHEMICAL TAX BILL WOULD PAY THE WAGES FOR THAT MANY ADDITIONAL EMPLOYEES

•

LIKEWISE, THE **INDIRECT TAXES** OF $2 BILLION WOULD PAY ALL FEDERAL STATE, LOCAL AND GOVERNMENTAL EXPENSES



**FOR 58½ DAYS**

**EVEN IN 1937**

•

**INDIRECT TAXES ARE PAID FROM LOW AND MODERATE INCOMES**

Annual Income $960
Paid in Indirect
Taxes $116.04

| $80 MONTHLY INCOME | | | $150 MONTHLY INCOME | |
|---|---|---|---|---|
| COST PER MONTH | AMOUNT OF TAXES | SPENT FOR | COST PER MONTH | AMOUNT OF TAXES |
| $27.00 | $1.92 | Food | $43.00 | $3.09 |
| 18.00 | 4.55 | Shelter | 30.00 | 7.59 |
| 9.00 | .72 | Clothing | 16.00 | 1.28 |
| 6.00 | .57 | Fuel and Light | 11.00 | 1.05 |
| 4.00 | .44 | Transportation | 14.50 | 2.91 |
| 2.00 | .20 | Recreation | 3.00 | .30 |
| 2.00 | .05 | Insurance | 5.00 | .13 |
| 12.00 | 1.22 | Sundries and Misc. | 27.00 | 2.75 |
| $80.00 | $9.67 | TOTALS | $150.00 | $19.10 |

Annual Income $1800
Paid in Indirect
Taxes $229.20

From study made by Northwestern National Life Insurance Co., Minneapolis, Minn.

# SOME CHEMICAL TAXES
## we all help to pay . . . . . .

CONSIDER the sale of one carload of 72 drums, each containing 54 gal. of chemically pure ethyl alcohol, made from molasses and to be sold for beverage use. Delivered in New York at 23 cents per proof gallon, the alcohol itself (including cost of drums and freight) is worth $1,699.06. But the federal tax of $2 per proof gallon amounts to $14,774.40 on this one shipment. If this sale is to a rectifier for blending purposes, there is an additional rectification tax of 30 cents per proof gallon, or $2,216.16. And since New York State also exacts from the wholesaler a tax of $1 per proof gallon or $7,387.20, we have the anomalous situation of one chemical product carrying a tax burden 14.4 times its actual value.

CONSIDER an example in the heavy chemical industry—say, in the production of an ordinary (5:10:5) commercial fertilizer containing 10 per cent of $P_2O_5$ in superphosphate. To produce this product we start with sulphur mined in Louisiana where there is a severance or extraction tax of $2 per long ton and in addition other local, state and federal taxes. To make a short ton of 50 deg. sulphuric acid from this sulphur requires 0.2 long ton of sulphur on which the tax was about 67¢, but in addition the taxes paid by the acid manufacturer bring our total tax up to nearly $1. Now to produce a ton of superphosphate requires 0.53 ton of 50 deg. sulphuric acid so that by now the accumulated tax amounts to about 73¢ per ton of superphosphate. One ton of superphosphate is mixed with 0.38 ton of ammonium sulphate, which required acid equivalent to about 0.09 long ton of sulphur in its production and carried additional federal and state taxes bringing its total to about 91¢. Now 0.16 ton of potassium chloride of 50 per cent $K_2O$ content is added with its own taxes of at least 10¢. Finally enough filler is added to bring the total weight of fertilizer to 1.6 tons of fertilizer which when bagged and tagged and taxed again is sold to the farmer. Problem: How much of the farmer's money for fertilizer goes to the tax collector?

NOW CONSIDER the producer of petroleum who pumps the crude oil from the ground in Oklahoma, pays a state extraction tax of 6¢ per bbl. of 42 gal. He pumps it to the refinery, paying 1¢ in pipe line tax. On refining it, he gets 18.5 gal. of gasoline, 16.1 gal. of fuel oil, and 5 qt. of motor oil. In doing this he creates the basis for other taxes. The gasoline alone, sold in New Orleans, La., for instance, must carry 1¢ federal tax, 7¢ state tax, and 2¢ city tax, a total of 10¢ taxes per gal. Lubricating oil carries a 4¢ per gal. federal tax. Fuel oil carries a 1¢ per gal. tax if sold in the neighboring state of Mississippi. In other words, starting with a barrel of crude oil worth approximately $1.22—chemical industry has provided $2.18 in direct petroleum taxes for federal, state, and local governments. Other taxes, the so-called "hidden taxes," imposed upon the petroleum industry, often are equivalent to 25¢ on a barrel of crude oil. Thus, the tax burden picked up by a barrel of crude oil from the well to the consumer may amount to more than twice its original value.

$ $ $ $ $ $ $ $ $ $ $ $ $ $ $

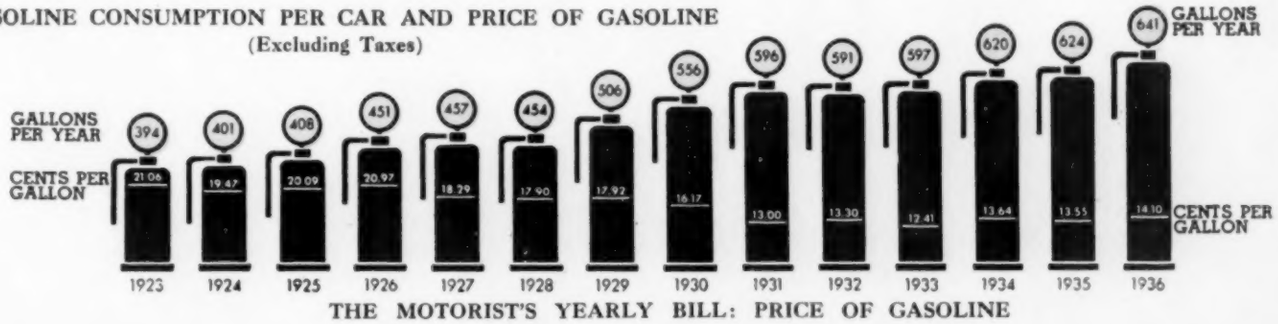
# Uncle Sam Looks to PROCESS INDUSTRIES For 1/5 of his ANNUAL INCOME

## FEDERAL TAXES ON PROCESS INDUSTRIES

Estimated federal income for fiscal year 1937-38, as forecast by the Budget submitted by the President early in 1937.

| | |
|---|---|
| **ALCOHOLIC-BEVERAGE TAXES:** | |
| Distilled spirits (imported) (excise tax) | $24,000,000 |
| Distilled spirits (domestic) (excise tax) | 267,000,000 |
| Fermented malt liquors (beer) | 310,000,000 |
| Wines (domestic and imported) (excise tax) | 6,100,000 |
| Rectification tax | 11,200,000 |
| Rectifiers, liquor dealers and stills (special taxes) | 7,500,000 |
| Containers stamps (Liquor Taxing Act, 1934) | 11,200,000 |
| Floor taxes (Liquor Taxing Act, 1934) | ..... |
| Brewer; retail and wholesale dealers in malt liquors (special taxes) | 4,100,000 |
| Other alcoholic beverage taxes | 2,600,000 |
| TOTAL | $643,700,000 |
| **TOBACCO TAXES:** | |
| Cigars (large) | 13,200,000 |
| Cigarettes (small) | 492,000,000 |
| Snuff | 7,000,000 |
| Tobacco, chewing, and smoking | 55,800,000 |
| Cigarette papers and tubes | 1,200,000 |
| Other tobacco taxes | 147,000 |
| TOTAL | $569,347,000 |
| **MANUFACTURERS' EXCISE TAXES:** | |
| Lubricating oils | 33,300,000 |
| Brewers' wort, malt, grape concentrates, etc | 900,000 |
| Matches | 7,200,000 |
| Gasoline | 204,000,000 |
| Tires and inner tubes | 37,000,000 |
| Toilet preparations, etc | 15,900,000 |
| **SUNDRY TAXES:** | |
| Transportation of oil by pipe line | 11,000,000 |
| Oleomargarine, etc., including special taxes | 2,800,000 |
| Coconut, and other vegetable oils, processed | 11,200,000 |
| Processing tax on crude petroleum | 1,000,000 |
| APPROXIMATE TOTAL FOR PROCESS INDUSTRIES | $1,500,000,000 |
| Grand total estimated income of Federal Government | $7,293,607,197 |

### GASOLINE CONSUMPTION PER CAR AND PRICE OF GASOLINE
(Excluding Taxes)




### THE MOTORIST'S YEARLY BILL: PRICE OF GASOLINE

© American Petroleum Institute

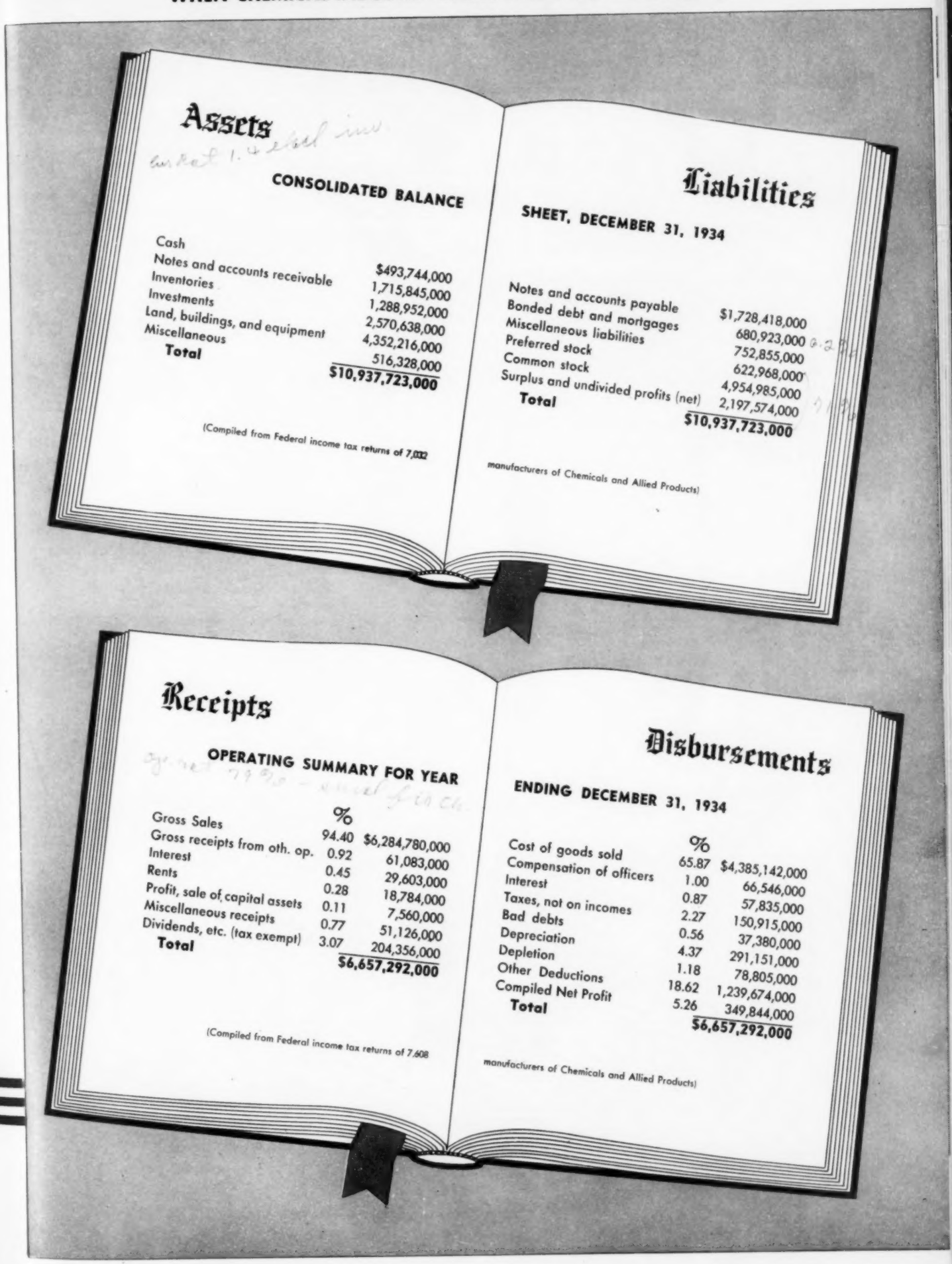
# BALANCE SHEET OF AMERICAN CHEMICAL INDUSTRY

A FINANCIAL ANALYSIS of chemical industry reveals that as a whole it is built on sound economic policy and is one of the most stable of American industries. This is important from the standpoint of the investor because it means a greater assurance of return on his investment. It is equally important to employees in the industry because it represents certainty of a job, and to buyers of chemicals and to the general public because it ensures a steady future chemical supply.

The data for this analysis have been obtained from the composite tax returns released by the U. S. Treasury Department. No other agency brings together as complete a summary of the assets and liabilities, receipts and disbursements, for the enterprises engaged in the manufacture of chemicals and allied products. Profits, however, which are a modest percentage of the cost of chemicals, are but crudely shown by the Internal Revenue data. In some cases the distributable profit is greater, in other cases less, than the so-called "net income." But on the average the figures for net income of an industry or a group of industries perhaps most fairly represent the reward to the investor, speaking of reward or profit in the most general terms.

The data which follow show some of the major financial comparisons between chemical industry and other industries and indicate trends both in the strictly chemicals business and in the group which tax collectors call "chemicals and allied products."

## WHEN CHEMICAL INDUSTRY OPENS ITS BOOKS TO UNCLE SAM



# Assets

**CONSOLIDATED BALANCE**

| | |
|---|---|
| Cash | $493,744,000 |
| Notes and accounts receivable | 1,715,845,000 |
| Inventories | 1,288,952,000 |
| Investments | 2,570,638,000 |
| Land, buildings, and equipment | 4,352,216,000 |
| Miscellaneous | 516,328,000 |
| **Total** | **$10,937,723,000** |

(Compiled from Federal income tax returns of 7,032

# Liabilities

**SHEET, DECEMBER 31, 1934**

| | |
|---|---|
| Notes and accounts payable | $1,728,418,000 |
| Bonded debt and mortgages | 680,923,000 |
| Miscellaneous liabilities | 752,855,000 |
| Preferred stock | 622,968,000 |
| Common stock | 4,954,985,000 |
| Surplus and undivided profits (net) | 2,197,574,000 |
| **Total** | **$10,937,723,000** |

manufacturers of Chemicals and Allied Products)

# Receipts

**OPERATING SUMMARY FOR YEAR**

| | % | |
|---|---|---|
| Gross Sales | 94.40 | $6,284,780,000 |
| Gross receipts from oth. op. | 0.92 | 61,083,000 |
| Interest | 0.45 | 29,603,000 |
| Rents | 0.28 | 18,784,000 |
| Profit, sale of capital assets | 0.11 | 7,560,000 |
| Miscellaneous receipts | 0.77 | 51,126,000 |
| Dividends, etc. (tax exempt) | 3.07 | 204,356,000 |
| **Total** | | **$6,657,292,000** |

(Compiled from Federal income tax returns of 7,608

# Disbursements

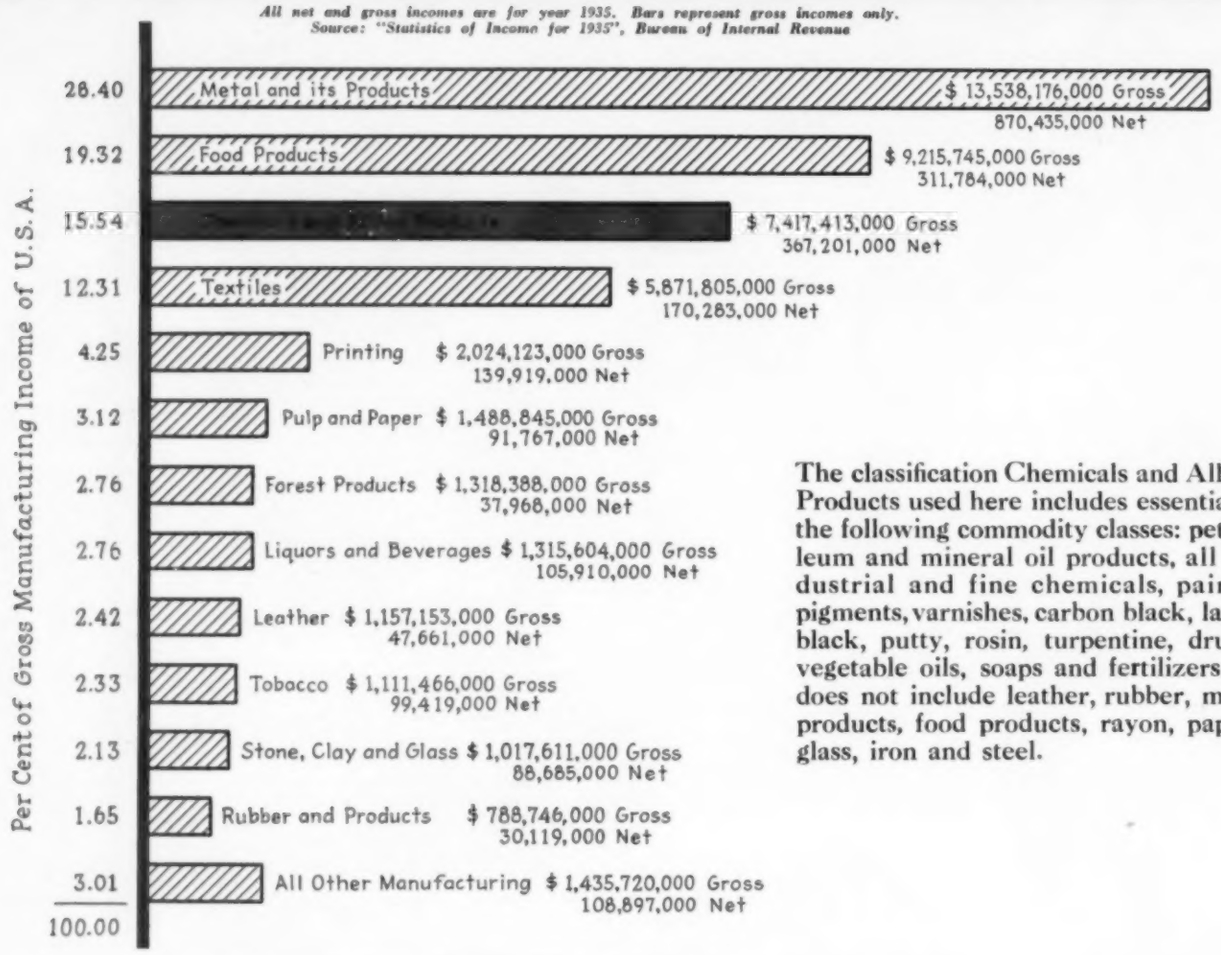
**ENDING DECEMBER 31, 1934**

| | % | |
|---|---|---|
| Cost of goods sold | 65.87 | $4,385,142,000 |
| Compensation of officers | 1.00 | 66,546,000 |
| Interest | 0.87 | 57,835,000 |
| Taxes, not on incomes | 2.27 | 150,915,000 |
| Bad debts | 0.56 | 37,380,000 |
| Depreciation | 4.37 | 291,151,000 |
| Depletion | 1.18 | 78,805,000 |
| Other Deductions | 18.62 | 1,239,674,000 |
| Compiled Net Profit | 5.26 | 349,844,000 |
| **Total** | | **$6,657,292,000** |

manufacturers of Chemicals and Allied Products)

# GROSS and NET INCOMES of MANUFACTURING INDUSTRIES

*All net and gross incomes are for year 1935. Bars represent gross incomes only.*
*Source: "Statistics of Income for 1935", Bureau of Internal Revenue*


Per Cent of Gross Manufacturing Income of U. S. A.
28.40 Metal and its Products $ 13,538,176,000 Gross 870,435,000 Net
19.32 Food Products $ 9,215,745,000 Gross 311,784,000 Net
15.54 $ 7,417,413,000 Gross 367,201,000 Net
12.31 Textiles $ 5,871,805,000 Gross 170,283,000 Net
4.25 Printing $ 2,024,123,000 Gross 139,919,000 Net
3.12 Pulp and Paper $ 1,488,845,000 Gross 91,767,000 Net
2.76 Forest Products $ 1,318,388,000 Gross 37,966,000 Net
2.76 Liquors and Beverages $ 1,315,604,000 Gross 105,910,000 Net
2.42 Leather $ 1,157,153,000 Gross 47,661,000 Net
2.33 Tobacco $ 1,111,466,000 Gross 99,419,000 Net
2.13 Stone, Clay and Glass $ 1,017,611,000 Gross 88,685,000 Net
1.65 Rubber and Products $ 788,746,000 Gross 30,119,000 Net
3.01 All Other Manufacturing $ 1,435,720,000 Gross 108,897,000 Net
100.00

Total Gross Income From All Manufacturing
$47,700,795,000

The classification Chemicals and Allied Products used here includes essentially the following commodity classes: petroleum and mineral oil products, all industrial and fine chemicals, paints, pigments, varnishes, carbon black, lamp black, putty, rosin, turpentine, drugs, vegetable oils, soaps and fertilizers. It does not include leather, rubber, mine products, food products, rayon, paper, glass, iron and steel.

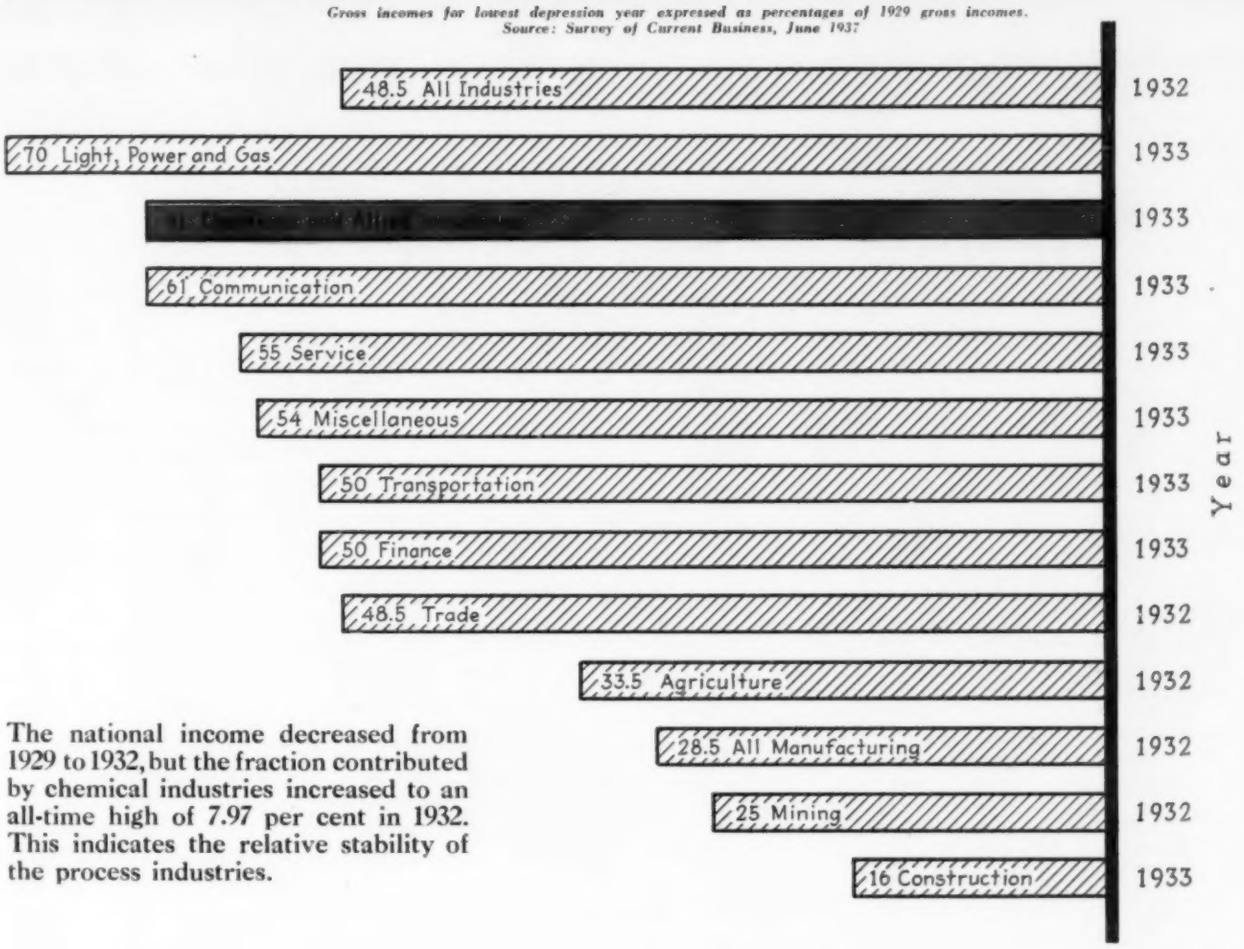
## The Growth of an Industry—Chemicals Proper (Industrial and Fine Chemicals)

| | Corporations reporting net income | | | | | | Corporations reporting no net income | | | Inactive Corp's no income data reported. Number of returns |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total No. of returns | Number of returns | Gross income | Net income | Net loss for prior year | Income Tax | Number of returns | Gross income | Deficit | |
| 1927..... | 412 | 220 | $835,035,391 | $94,744,345 | $323,492 | $11,347,923 | 192 | $24,917,320 | $4,648,711 | 20 |
| 1928..... | 467 | 250 | 791,792,937 | 102,714,248 | 152,691 | 12,272,447 | 180 | 32,108,439 | 3,486,665 | 37 |
| 1929..... | 500 | 276 | 1,026,514,325 | 125,974,068 | 563,699 | 13,753,713 | 184 | 19,339,135 | 2,662,885 | 40 |
| 1930..... | 394 | 185 | 852,970,523 | 82,745,458 | 363,131 | 9,315,322 | 175 | 78,964,773 | 6,784,056 | 34 |
| 1931..... | 343 | 146 | 642,417,000 | 49,246,000 | 44,000 | 5,882,000 | 167 | 40,253,000 | 4,067,000 | 30 |
| 1932..... | 294 | 100 | 441,233,000 | 21,793,000 | 35,000 | 3,120,000 | 178 | 39,727,000 | 4,146,000 | 16 |
| 1933..... | 370 | 173 | 502,383,000 | 48,014,000 | (Not reported) | 6,781,000 | 169 | 17,665,000 | 2,464,000 | 28 |
| 1934..... | 559 | 260 | 590,230,000 | 72,551,000 | (Not reported) | 9,976,000 | 260 | 30,711,000 | 3,630,000 | 39 |
| 1935..... | Not available | | | | | | | | | |

Source: "Statistics of Income," Bureau of Internal Revenue.

# HOW CHEMICAL INDUSTRY WEATHERED THE DEPRESSION

*Gross incomes for lowest depression year expressed as percentages of 1929 gross incomes.*
*Source: Survey of Current Business, June 1937*




The national income decreased from 1929 to 1932, but the fraction contributed by chemical industries increased to an all-time high of 7.97 per cent in 1932. This indicates the relative stability of the process industries.

## The Growth of an Industry—Chemicals and Allied Products

| Year | Total No. of returns | Corporations reporting net income: Number of returns | Gross income | Net income | Net loss for prior year | Income Tax | Corporations reporting no net income: Number of returns | Gross income | Deficit | Inactive Corp's no income data reported. Number of returns |
|---|---|---|---|---|---|---|---|---|---|---|
| 1927..... | 7,229 | 3,960 | $6,799,331,331 | $495,857,272 | $8,398,156 | $64,766,564 | 2,892 | $1,969,078,193 | $110,369,015 | 377 |
| 1928..... | 7,501 | 4,231 | 8,722,465,670 | 848,126,502 | 14,826,214 | 99,001,700 | 2,820 | 778,525,660 | 59,789,284 | 450 |
| 1929..... | 7,505 | 4,073 | 9,550,544,726 | 911,512,070 | 16,509,969 | 98,124,032 | 2,998 | 737,015,934 | 56,976,431 | 434 |
| 1930..... | 7,380 | 3,287 | 7,376,017,000 | 534,077,263 | 4,277,037 | 62,960,658 | 3,727 | 2,351,166,058 | 175,459,039 | 366 |
| 1931..... | 7,295 | 2,779 | 3,371,395,000 | 251,493,000 | 4,774,000 | 29,409,000 | 4,047 | 3,952,977,000 | 318,864,000 | 421 |
| 1932..... | 7,443 | 1,741 | 2,761,691,000 | 107,778,000 | 5,457,000 | 22,844,000 | 5,315 | 3,096,099,000 | 223,266,000 | 387 |
| 1933..... | 7,078 | 2,458 | 4,094,654,000 | 272,909,000 | (Not reported) | 38,776,000 | 4,696 | 2,191,132,000 | 139,213,000 | 524 |
| 1934..... | 8,220 | 3,049 | 3,322,986,000 | 324,031,000 | (Not reported) | 44,627,000 | 4,550 | 3,325,574,000 | 178,543,000 | 612 |
| 1935..... | 7,967 | 3,156 | 4,544,633,000 | 367,201,000 | (Not reported) | 50,350,000 | 4,348 | 2,872,780,000 | 114,051,000 | 463 |

Source: "Statistics of Income," Bureau of Internal Revenue.

# FINANCIAL ANALYSIS

In Thousands of Dollars

| | Total Tangible Assets | Total Current Assets | Total Current Liabilities | Cash and Marketable Securities | Net Working Capital | Net Property Investment | Investment in Subsidiaries, and Other Tangible Assets | Net Sales | Net Income after Taxes | Fiscal Year Ending |
|---|---|---|---|---|---|---|---|---|---|---|
| Air Reduction Co. | 34,855 | 21,709 | 4,215 | 16,090 | 17,494 | 13,695 | 5,910 | 27,833 | 7,064 | Dec. 31 1936 |
| Allied Chemical & Dye Corp. | 190,956 | 97,201 | 13,654 | 62,027 | 83,547 | 76,609 | 28,800 | ..... | 25,323 | Dec. 31 1936 |
| Aluminum Co. of America | 166,901 | 50,287 | 30,141 | 4,855 | 20,146 | 133,567 | 35,961 | ..... | 22,095 | Dec. 31 1936 |
| Amer. Agricultural Chemical Co. | 17,992 | 13,532 | 825 | 5,881 | 12,707 | 6,838 | 645 | ..... | 1,005 | June 30 1936 |
| American Catalin Corp. | ..... | 553 | 168 | ..... | 385 | ..... | ..... | 1,629 | *289 | Dec. 31 1936 |
| Amer. Commercial Alcohol Corp. | 8,749 | 10,266 | 6,925 | 649 | 3,340 | 5,937 | 250 | 35,463 | 887 | Dec. 31 1936 |
| American Cyanamid Co. | 41,611 | 27,761 | 7,471 | 8,565 | 20,289 | 24,100 | 5,190 | ..... | 4,454 | Dec. 31 1936 |
| Amer. I. G. Chemical Corp. | 40,556 | 2,955 | 927 | 35,542 | ..... | ..... | 27,108 | ..... | 4,684 | Mar. 31 1937 |
| Amer. Potash & Chemical Corp. | 16,596 | 3,505 | 716 | 1,607 | 2,789 | 13,737 | ..... | 6,032 | 1,907 | Dec. 31 1936 |
| Amer. Zinc, Lead & Smelting Co. | 7,348 | 3,665 | 848 | 464 | 2,816 | 4,532 | 144 | 9,621 | 52 | Dec. 31 1936 |
| Atlas Powder Co. | 16,271 | 9,563 | 1,276 | 4,172 | 8,286 | 6,778 | 1,266 | 15,895 | 1,430 | Dec. 31 1936 |
| Baker (J. T.) Chemical Co. | 1,493 | 996 | 364 | 39 | 632 | 738 | 12 | ..... | 182 | Dec. 31 1936 |
| Barium Reduction Corp. | 742 | 401 | 61 | 191 | 339 | 392 | ..... | ..... | ..... | Dec. 31 1936 |
| Colgate Palmolive-Peet Co. | 57,714 | 45,301 | 8,235 | 16,298 | 37,065 | 20,114 | 445 | 89,631 | 4,218 | Dec. 31 1936 |
| Columbian Carbon Co. | ..... | 7,487 | 1,522 | 4,142 | 5,965 | 37,695 | ..... | 13,872 | 4,021 | Dec. 31 1936 |
| Commercial Solvents Corp. | 16,140 | 14,057 | 1,935 | 3,386 | 12,122 | 4,018 | 974 | 47,856 | 2,232 | Dec. 31 1936 |
| Compressed Industrial Gases, Inc. | 2,693 | 1,000 | 323 | 286 | 677 | 1,607 | 409 | 2,442 | 355 | Dec. 31 1936 |
| Consolidated Chem. Industries, Inc. | 7,339 | 2,376 | 750 | 516 | 1,626 | 5,966 | 26 | ..... | 643 | Dec. 31 1936 |
| Davison Chemical Corp. | 9,452 | 6,325 | 592 | 2,783 | 5,732 | 4,473 | 96 | ..... | 184 | 1st 6 mos. '36 |
| Diamond Alkali Co. and Subs. | 40,947 | ..... | ..... | ..... | ..... | 30,858 | ..... | 15,723 | ..... | Dec. 31 1935 |
| Dow Chemical Co. | 25,134 | 12,924 | 3,708 | 4,187 | 9,216 | 21,788 | 557 | 25,578 | 4,089 | May 31 1937 |
| du Pont (E. I.) de Nemours & Co. | 536,317 | 155,229 | 32,307 | 75,815 | 122,922 | 221,989 | 213,521 | 260,333 | 89,884 | Dec. 31 1936 |
| Eastman Kodak Co. | 142,208 | 92,134 | 18,685 | 25,642 | 73,448 | 71,980 | 846 | 119,800 | 18,906 | Dec. 26 1936 |
| Emerson Drug Co. | 4,315 | 2,979 | 518 | 1,511 | 2,460 | 1,854 | 179 | 6,057 | 1,413 | Dec. 31 1936 |
| Freeport Sulphur Co. | 17,023 | 10,010 | 2,686 | 3,968 | 7,324 | 6,454 | 3,085 | 12,043 | 2,009 | Dec. 31 1936 |
| Glidden Company | 27,794 | 16,363 | 3,068 | 1,376 | 13,295 | 12,014 | 1,728 | 44,580 | 3,085 | Oct. 31 1936 |
| Great Western Electro-Chem. Co. | 3,096 | 1,304 | 361 | 381 | 942 | 2,100 | 14 | 2,719 | 475 | Dec. 31 1936 |
| Harshaw Chemical Co. | 3,448 | 2,916 | 1,037 | 338 | 1,879 | 1,490 | 14 | ..... | 369 | Dec. 31 1936 |
| Hercules Powder Co. | 32,495 | 17,833 | 2,778 | 5,161 | 15,055 | 16,355 | 1,083 | 36,740 | 4,284 | Dec. 31 1936 |
| Heyden Chemical Corp. | 3,579 | 1,465 | 433 | 582 | 1,032 | 2,547 | 105 | ..... | 555 | Dec. 31, 1936 |
| Hooker Electrochemical Co. | 11,992 | 1,958 | 508 | ..... | 1,449 | 11,954 | 241 | ..... | **634 | Nov. 30, 1936 |
| Interchemical Corp. | 11,585 | 7,881 | 1,920 | 1,393 | 5,961 | 5,624 | 817 | 17,446 | 1,269 | Dec. 31, 1936 |

Note: Total tangible assets consist of either fixed assets plus working capital, or capital stock plus surplus, whichever is lower.

# OF CHEMICAL INDUSTRY

In Thousands of Dollars

| | Total Tangible Assets | Total Current Assets | Total Current Liabilities | Cash and Marketable Securities | Net Working Capital | Net Property Investment | Investment in Subsidiaries, and Other Tangible Assets | Net Sales | Net Income after Taxes | Fiscal Year Ending |
|---|---|---|---|---|---|---|---|---|---|---|
| International Agricultural Corp... | 20,471 | 6,849 | 433 | 3,380 | 6,416 | 19,881 | 753 | ..... | 23 | June 30, 1936 |
| International Salt Co..... | 10,054 | 2,497 | 631 | 1,257 | 1,865 | 11,889 | 46 | ..... | 397 | Dec. 31, 1936 |
| Liquid Carbonic Corp..... | 15,678 | 8,528 | 1,502 | 1,433 | 7,026 | 8,652 | 260 | 13,705 | 1,106 | Sept. 30, 1936 |
| Mathieson Alkali Works, Inc..... | 24,035 | 3,663 | 1,061 | 807 | 2,601 | 21,434 | 239 | ..... | 1,628 | Dec. 31, 1936 |
| Merck & Co., Inc..... | 7,850 | 5,856 | 732 | 453 | 5,124 | 2,887 | 72 | ..... | 1,048 | Dec. 31, 1936 |
| Metal & Thermit Corp..... | 5,889 | 4,817 | 359 | 3,416 | 4,457 | 1,431 | 715 | ..... | ..... | Dec. 31, 1936 |
| Michigan Alkali Co..... | ..... | 20,081 | 3,554 | 12,853 | 16,527 | 25,980 | ..... | ..... | ..... | Dec. 31, 1935 |
| Monsanto Chemical Co..... | 29,344 | 16,144 | 3,743 | 7,308 | 12,401 | 18,719 | 664 | 28,848 | 4,468 | Dec. 31, 1936 |
| National Lead Co..... | 79,735 | 42,543 | 8,109 | 12,497 | 34,434 | 45,300 | 11,868 | 78,764 | 7,232 | Dec. 31, 1936 |
| Newport Industries, Inc..... | 3,406 | 1,731 | 468 | 328 | 1,262 | 2,144 | 495 | 4,363 | 507 | Dec. 31, 1936 |
| Niagara Sprayer & Chem. Co.... | 1,896 | 1,811 | 292 | 301 | 1,519 | 376 | 162 | ..... | ..... | Nov. 30 1936 |
| Noradel-Agene Corp..... | 1,770 | 1,100 | 716 | 663 | 384 | 1,386 | ..... | 2,043 | 1,224 | Dec. 31 1936 |
| Parke, Davis & Co..... | 36,087 | 24,781 | 6,165 | 10,984 | 18,616 | 6,380 | ..... | ..... | 9,213 | Dec. 31, 1936 |
| Penna. Salt Mfg. Co..... | 13,930 | 6,995 | 1,286 | 3,713 | 5,708 | 8,222 | 304 | ..... | 1,285 | June 30, 1936 |
| Pittsburgh Plate Glass Co..... | 94,701 | 47,158 | 9,447 | 22,881 | 37,710 | 60,271 | 5,573 | 86,110 | 15,321 | Dec. 31, 1936 |
| Procter & Gamble Co..... | 115,835 | 78,413 | 9,254 | 24,336 | 69,159 | 50,488 | 1,350 | 170,361 | 16,138 | June 30, 1936 |
| Sherwin-Williams Co..... | 44,294 | 31,761 | 4,664 | 6,239 | 27,097 | 17,196 | 3,764 | ..... | 5,887 | Aug. 31, 1936 |
| Southern Alkali Corp. & Sub..... | 9,538 | 902 | 4,071 | 117 | ..... | 8,339 | ..... | 2,850 | 365 | Dec. 31, 1936 |
| Squibb (E. R.) & Sons..... | 10,569 | 9,682 | 2,989 | 858 | 6,693 | 2,727 | 1,193 | ..... | 1,219 | Dec. 31, 1936 |
| Sylvania Industrial Corp..... | 5,788 | 1,625 | 836 | 192 | 788 | 4,999 | 322 | ..... | 1,161 | Dec. 31 1936 |
| Tennessee Corporation..... | 19,646 | 4,440 | 1,106 | 400 | 3,333 | 16,312 | 21 | 9,656 | 353 | Dec. 31, 1936 |
| Tennessee Products Corp..... | 5,775 | 987 | 84 | 185 | 903 | 5,989 | 3 | ..... | 36 | Dec. 31, 1936 |
| Texas Gulf Sulphur Co..... | 57,730 | 27,097 | 2,887 | 10,833 | 24,210 | 33,520 | 347 | 22,080 | 9,853 | Dec. 31, 1936 |
| Union Carbide & Carbon Corp... | 247,036 | 97,040 | 24,398 | 35,269 | 72,641 | 178,765 | 5,370 | ..... | 36,852 | Dec. 31, 1936 |
| United Carbon Co..... | 14,539 | 2,752 | 912 | 854 | 1,840 | 23,067 | ..... | 9,019 | 2,202 | Dec. 31, 1936 |
| U. S. Industrial Alcohol Co..... | 11,771 | 13,283 | 2,710 | 5,043 | 10,573 | 1,197 | 330 | ..... | 77 | Dec. 31, 1936 |
| Vanadium Corporation of America. | 9,890 | 3,192 | 400 | 714 | 2,792 | 10,093 | 75 | 5,353 | 152 | Dec. 31, 1936 |
| Victor Chemical Works..... | 5,449 | 2,826 | 433 | 1,100 | 2,394 | 2,561 | ..... | 2,860 | 342 | 1st 6 mos. '37 |
| Virginia-Carolina Chem. Corp.... | 20,238 | 9,091 | 907 | 3,643 | 8,183 | 14,154 | 1,242 | 12,583 | 93 | June 30, 1936 |
| Westvaco Chlorine Prods. Corp... | 10,192 | 2,096 | 322 | 947 | 1,806 | 8,386 | 33 | 6,913 | 626 | Dec. 31, 1936 |
| Zinsser & Co., Inc..... | 831 | 439 | 213 | 29 | 223 | 934 | 2 | 1,151 | 27 | Dec. 31, 1936 |

* Before Federal surtax. ** Before depreciation and obsolescence.

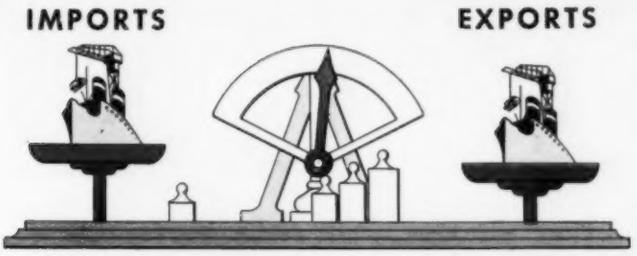
Source: The data for this compilation have been taken from official published sources and are believed to be the latest available.

# FOREIGN TRADE OF AMERICAN CHEMICAL INDUSTRY

SELF-SUFFICIENCY is an ideal, but not a practical achievement for any nation. The United States comes nearer to self-sufficiency than almost any other country; but even it requires foreign trade for the balance of its industry. And the chemical industry is no exception.

But the American chemical industry has recently maintained a very close balance between its imports and exports. The type of goods brought in is quite different from the type exported. Yet the dollar value is not significantly different if the analysis is confined to chemicals and closely related products. Thus the consumption of chemicals in the United States is about equal to its production and both these figures are approximately 11 times as important in dollars as are the goods coming in or going out.

This balance between imports and exports and the equality in values between production and consumption does not mean that the American chemical industry is independent of the rest of the world. But it does mean that chemical industry as a whole does not place a serious international trade burden on the nation. The advantage of this in the American economy is quite evident when one contrasts the situation of the United States with that of other countries where imports of requisite chemicals must be paid for by the goods of other industries.




# THE INDUSTRY HAD A FAVORABLE BALANCE OF TRADE IN 1936

$151,627,000 Exports
− $131,859,000 Imports
$19,768,000 Chemical Balance

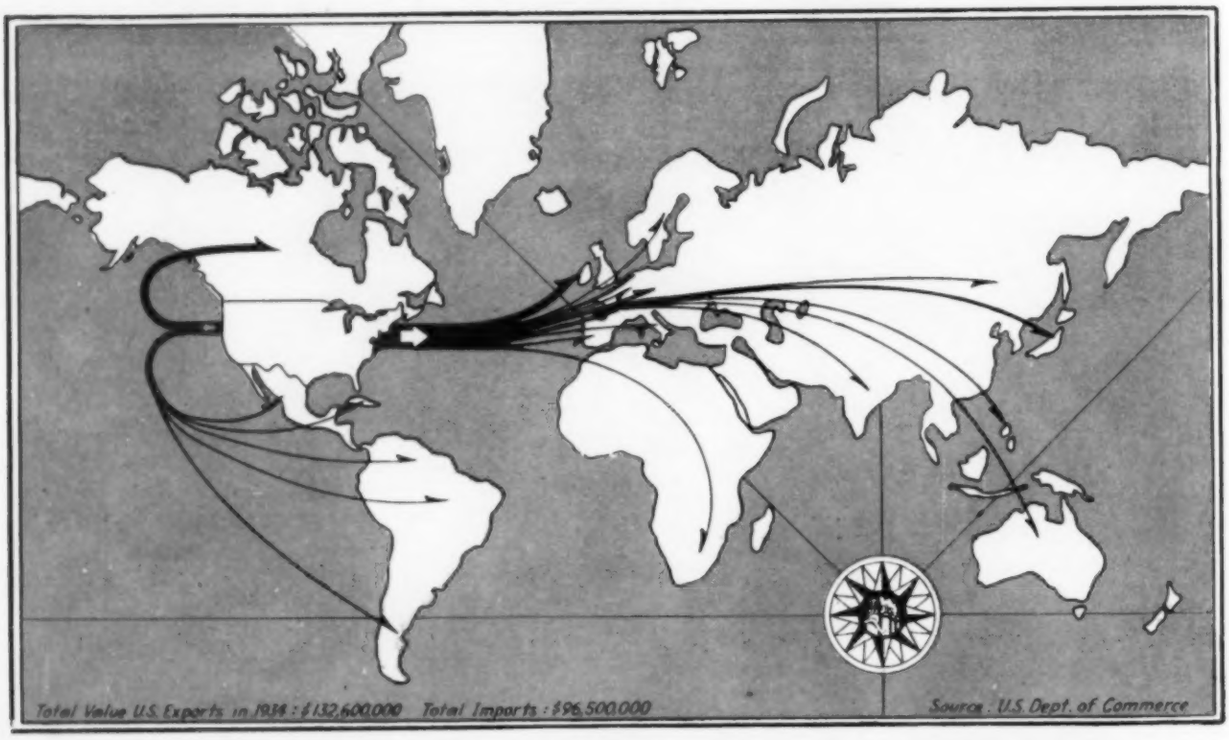
## MAJOR ITEMS IN CHEMICAL FOREIGN TRADE IN 1936

**Total $131,859,000**

**Total $151,627,000**

| Value Thousands $ | Commodity | RANK | Commodity | Value Thousands $ |
|---|---|---|---|---|
| $17,838 | Tung Oil | 1 | Rosin | $11,236 |
| 9,160 | Sodium Nitrate | 2 | Sulphur | 10,894 |
| 5,698 | Coal-Tar Dyes | 3 | Carbon and Gas Black | 7,250 |
| 5,194 | Potassium Chloride | 4 | Phosphate Rock | 6,743 |
| 4,566 | Creosote Oil | 5 | Coal-Tar Dyes | 6,081 |
| 3,269 | Ammonium Sulphate | 6 | Turpentine | 5,175 |
| 2,901 | Sodium Cyanide | 7 | Mixed Paints | 3,847 |
| 2,622 | Calcium Cyanamid | 8 | Pyroxylin Sheets, Etc. | 3,393 |
| 2,485 | Coal-Tar Intermediates | 9 | Other Nitrogenous Materials | 3,243 |
| 2,096 | Perfume and Materials | 10 | Borax | 3,120 |
| 2,095 | Varnish Gums | 11 | Sodium Hydroxide | 3,082 |
| 2,090 | Potassium Sulphate | 12 | Benzol | 2,918 |
| 2,072 | Other Coal-Tar Crudes | 13 | Soap and Powders | 2,729 |
| 1,793 | Glycerine | 14 | Ammonium Sulphate | 2,682 |
| 1,733 | Camphor | 15 | Gums | 2,513 |
| 1,701 | Potassium Nitrate | 16 | Nitrocellulose Lacquers | 2,167 |
| 1,518 | Acetic Acid | 17 | Sodium Carbonate | 1,095 |
| 1,449 | Ammonium Nitrate | 18 | Petroleum Jelly | 1,085 |
| 1,334 | Salt Cake | 19 | Cellulose Solutions | 779 |

# Where U. S. Chemicals Go Abroad




## U. S. CHEMICAL EXPORTS OF MAJOR CLASSES, BY COUNTRIES OF DESTINATION

**Value in thousands of dollars**

*Source: Chemical Division, Bureau of Foreign and Domestic Commerce*

| | Total, all Chemicals | | Coal-Tar Products | | Medicinal and Pharmaceutical Preparations | | Chemical Specialties and Industrial Chemicals | | Pigments, Paints, Lacquers, Varnishes | | Fertilizers and Materials | | Naval Stores | | Sulphur | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1934 | *1935 | 1934 | 1936 | 1934 | 1936 | 1934 | 1936 | 1934 | 1936 | 1934 | 1936 | 1934 | 1936 | 1934 | 1936 |
| Total | 123,159 | 136,436 | 13,264 | 13,775 | 10,945 | 14,393 | 33,282 | 42,547 | 14,207 | 17,789 | 12,537 | 17,784 | 14,489 | 18,924 | 9,763 | 10,894 |
| Europe | 50,399 | 53,738 | 6,862 | 6,502 | 2,178 | 2,326 | 10,158 | 14,842 | 6,128 | 7,012 | 6,578 | 7,415 | 8,736 | 11,649 | 4,922 | 5,156 |
| Austria | 125 | ..... | 18 | 15 | 5 | 15 | 62 | 90 | 12 | 12 | ..... | 46 | 6 | 5 | 4 | ..... |
| Belgium | 2,702 | 3,610 | 1,100 | 2,901 | 53 | 80 | 372 | 586 | 376 | 508 | 337 | 1,027 | 311 | 277 | 73 | 205 |
| Czechoslovakia | 267 | ..... | 171 | 108 | 133 | 2 | 12 | 44 | ..... | 13 | 55 | 30 | ..... | 3 | ..... | ..... |
| Denmark | 855 | 906 | 24 | 1 | 28 | 7 | 147 | 102 | 110 | 113 | 358 | 240 | 159 | 169 | 12 | 17 |
| Finland | 567 | ..... | 2 | 22 | 3 | 12 | 83 | 113 | 38 | 56 | 16 | 50 | 45 | 132 | 375 | 192 |
| France | 8,373 | 4,905 | 3,363 | 1,766 | 38 | 45 | 1,201 | 1,686 | 1,141 | 1,285 | 1,079 | 116 | 10 | 29 | 1,340 | 12 |
| Germany | 7,013 | 8,134 | 226 | 133 | 91 | 68 | 1,625 | 1,768 | 790 | 778 | 1,066 | 2,299 | 1,864 | 251 | 808 | 873 |
| Italy | 2,050 | 2,311 | 279 | 176 | 67 | 49 | 405 | 366 | 361 | 288 | 572 | 498 | 264 | 24 | ..... | 32 |
| Netherlands | 5,018 | 6,225 | 862 | 622 | 55 | 154 | 727 | 990 | 315 | 330 | 1,170 | 1,359 | 1,140 | 1,713 | 442 | 405 |
| Spain | 1,729 | 3,038 | 169 | 122 | 194 | 122 | 235 | 122 | 245 | 152 | 817 | 535 | 9 | 11 | ..... | ..... |
| Sweden | 2,081 | 2,210 | 20 | 64 | 32 | 55 | 411 | 674 | 308 | 338 | 381 | 579 | 293 | 422 | 866 | 128 |
| United Kingdom | 17,108 | 18,705 | 368 | 392 | 1,438 | 1,480 | 3,310 | 7,620 | 2,047 | 2,591 | 179 | 249 | 4,417 | 5,399 | 1,104 | 1,443 |
| North America, West Indies | 33,557 | 37,267 | 2,080 | 2,668 | 3,258 | 4,830 | 13,140 | 15,783 | 3,477 | 4,308 | 2,432 | 2,679 | 1,847 | 2,004 | 3,270 | 3,599 |
| Canada | 20,918 | 22,523 | 1,602 | 2,111 | 774 | 1,162 | 8,703 | 10,319 | 1,787 | 2,153 | 1,647 | 2,057 | 1,415 | 1,606 | 2,759 | 2,963 |
| Honduras | 550 | ..... | 3 | 1 | 126 | 147 | 131 | 180 | 78 | 61 | 85 | 11 | 4 | 3 | 4 | 5 |
| Panama | 1,046 | 1,333 | 13 | 16 | 258 | 331 | 251 | 265 | 251 | 307 | 8 | 5 | 38 | 32 | 1 | 1 |
| Mexico | 4,482 | 5,087 | 331 | 385 | 402 | 912 | 2,096 | 2,657 | 508 | 637 | 115 | 98 | 44 | 74 | 247 | 227 |
| Cuba | 3,056 | ..... | 61 | 102 | 939 | 1,385 | 979 | 1,324 | 313 | 464 | 353 | 336 | 212 | 204 | 6 | 5 |
| Neth. West Indies | 638 | ..... | 23 | 5 | 43 | 53 | 240 | 309 | 104 | 152 | 5 | 1 | 1 | 7 | 173 | 253 |
| Br. West Indies | 884 | 1,101 | 4 | 6 | 260 | 297 | 156 | 204 | 115 | 215 | 113 | 133 | 61 | 25 | ..... | ..... |
| South America | 11,560 | 12,019 | 585 | 644 | 2,177 | 2,770 | 3,740 | 4,149 | 1,717 | 2,384 | 46 | 53 | 1,513 | 2,017 | 280 | 125 |
| Argentina | 3,719 | 3,939 | 224 | 225 | 542 | 581 | 1,365 | 1,398 | 605 | 830 | 1 | 4 | 601 | 837 | 201 | 68 |
| Brazil | 2,467 | 2,275 | 205 | 238 | 336 | 223 | 822 | 774 | 394 | 458 | 3 | 5 | 510 | 677 | 62 | 24 |
| Colombia | 1,780 | 1,793 | 58 | 53 | 560 | 781 | 496 | 618 | 252 | 397 | 8 | 12 | 128 | 159 | 6 | 9 |
| Venezuela | 1,018 | ..... | 14 | 31 | 384 | 71 | 233 | 317 | 192 | 252 | 6 | 13 | 32 | 45 | 1 | 2 |
| Asia and Oceania | 24,428 | 29,169 | 3,705 | 3,920 | 2,962 | 3,917 | 5,350 | 6,761 | 2,208 | 3,128 | 2,960 | 6,808 | 2,231 | 3,019 | 1,126 | 1,487 |
| India | 3,126 | 3,677 | 517 | 309 | 1,206 | 1,357 | 495 | 461 | 210 | 240 | 44 | 87 | 113 | 98 | 11 | 12 |
| China, Hong Kong | 4,867 | 4,795 | 2,063 | 1,928 | 364 | 543 | 646 | 817 | 217 | 297 | 41 | 45 | 132 | 171 | 50 | 88 |
| Japan | 6,160 | 7,920 | 747 | 1,350 | 178 | 287 | 1,609 | 2,095 | 444 | 812 | 1,999 | 5,270 | 875 | 1,475 | ..... | ..... |
| Philippine Islands | 3,603 | 4,913 | 46 | 36 | 693 | 943 | 702 | 809 | 435 | 683 | 732 | 1,174 | 63 | 63 | 2 | 2 |
| Australia | 3,539 | 4,072 | 73 | 89 | 181 | 253 | 1,028 | 1,366 | 527 | 538 | 37 | 99 | 507 | 694 | 857 | 1,083 |
| New Zealand | 664 | ..... | 15 | 5 | 18 | 47 | 209 | 243 | 91 | 102 | ..... | ..... | 92 | 85 | 198 | 266 |
| Africa | 3,215 | 4,243 | 32 | 41 | 360 | 550 | 894 | 1,012 | 677 | 987 | 521 | 829 | 162 | 235 | 165 | 527 |
| Union South Africa | 1,897 | 2,242 | 8 | 14 | 209 | 306 | 490 | 654 | 577 | 846 | 88 | 262 | 117 | 170 | 13 | 332 |
| Other Br. Africa | 212 | ..... | 3 | 1 | 52 | 117 | 86 | 83 | 11 | 16 | 20 | 21 | 1 | 8 | ..... | 3 |
| Egypt | 533 | 792 | 2 | 14 | 74 | 95 | 85 | 99 | 20 | 29 | 315 | 477 | 4 | 5 | ..... | 1 |
| Portuguese Africa | 251 | ..... | 1 | 6 | 13 | 12 | 79 | 73 | 24 | 34 | 82 | 61 | 40 | 48 | 2 | 12 |

* The 1935 totals are given for comparison because the 1936 figures are still incomplete.

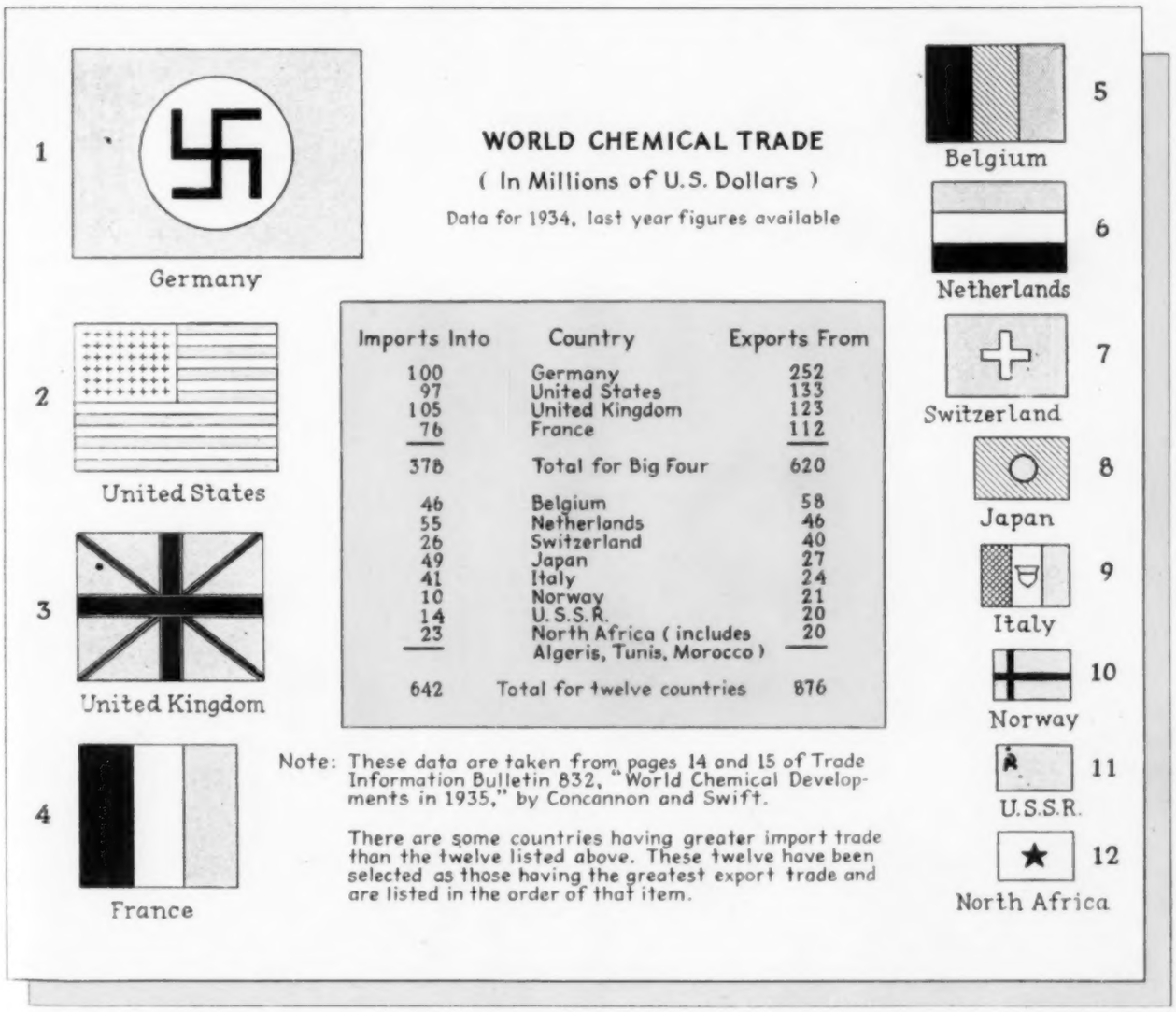
## U. S. CHEMICAL IMPORTS OF MAJOR CLASSES, BY COUNTRIES OF ORIGIN

**Value in thousands of dollars**

*Source: Chemical Division, Bureau of Foreign and Domestic Commerce*

| | Total, all Chemicals | | Coal-Tar Products | | Medicinal and Pharmaceutical Preparations | | Industrial Chemicals | | Pigments Paints, Varnishes | | Fertilizers and Materials | | Gums, Resins, Balsams | | Drugs, Herbs, Botanicals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1934 | 1935 | 1934 | 1935 | 1934 | 1935 | 1934 | 1935 | 1934 | 1935 | 1934 | 1935 | 1934 | 1935 | 1934 | 1935 |
| Total | 97,024 | 113,456 | 11,847 | 13,558 | 4,237 | 4,128 | 17,479 | 17,393 | 1,695 | 2,109 | 26,029 | 27,317 | 9,115 | 10,997 | 6,547 | 7,594 |
| Europe | 50,035 | 54,390 | 11,108 | 12,504 | 3,065 | 3,334 | 10,670 | 10,828 | 1,587 | 1,930 | 13,443 | 13,185 | 1,199 | 1,932 | 1,911 | 2,632 |
| Belgium | 3,525 | 3,756 | 930 | 1,081 | 43 | 83 | 1,740 | 1,371 | 81 | 74 | 507 | 738 | 105 | 294 | 66 | 47 |
| Czechoslovakia | 256 | ..... | 45 | 98 | 2 | 4 | 198 | 178 | 2 | 1 | 4 | 15 | 2 | 1 | 1 | 3 |
| France | 5,577 | 5,413 | 78 | 98 | 339 | 396 | 1,118 | 945 | 172 | 205 | 139 | 141 | 114 | 100 | 160 | 143 |
| Germany | 17,770 | 20,393 | 5,151 | 5,697 | 738 | 1,236 | 4,790 | 5,873 | 315 | 372 | 5,234 | 6,133 | 634 | 525 | 433 | 130 |
| Italy | 1,186 | 1,337 | 1 | 1 | 82 | 77 | 318 | 346 | 2 | 151 | 2 | 1 | 66 | 114 | 170 | 195 |
| Netherlands | 6,725 | 6,339 | 195 | 287 | 1,344 | 976 | 701 | 521 | 408 | 400 | 3,833 | 3,384 | .... | 2 | 62 | 547 |
| Norway | 1,440 | ..... | .... | .... | .... | .... | 82 | 60 | .... | 1 | 1,309 | 1,287 | 2 | 2 | 46 | 62 |
| Spain | 3,488 | 3,132 | .... | 1 | 4 | 2 | 218 | 128 | 141 | 261 | 1543 | 758 | .... | 11 | 177 | 275 |
| Switzerland | 3,199 | 3,696 | 2,626 | 3,085 | 251 | 308 | 146 | 175 | 4 | 3 | .... | .... | .... | 2 | 11 | 15 |
| United Kingdom | 4,766 | 6,044 | 1,978 | 2,016 | 201 | 194 | 815 | 788 | 326 | 398 | 504 | 454 | 252 | 816 | 301 | 422 |
| North America and West Indies | 11,185 | 14,493 | 580 | 746 | 28 | 28 | 3,859 | 4,714 | 92 | 150 | 3,888 | 4,387 | 1,687 | 2,200 | 233 | 477 |
| Canada | 8,061 | 10,239 | 566 | 719 | 26 | 26 | 3,256 | 3,925 | 89 | 150 | 3,798 | 4,248 | 7 | 9 | 98 | 247 |
| Mexico | 1,782 | 2,592 | 14 | 27 | 2 | 2 | 506 | 526 | .... | .... | 53 | 95 | 1,205 | 1,650 | 24 | 34 |
| South America | 12,362 | 14,795 | .... | .... | 10 | 15 | 2,346 | 1,308 | .... | .... | 6,854 | 8,732 | 63 | 64 | 140 | 268 |
| Argentina | 1,111 | 1,480 | .... | .... | .... | .... | 195 | 149 | .... | .... | 222 | 366 | .... | .... | 46 | 74 |
| Brazil | 1,902 | 3,315 | .... | .... | 10 | 10 | .... | 6 | .... | .... | 3 | 60 | 31 | 18 | 9 | 80 |
| Chile | 8,689 | 9,335 | .... | .... | .... | .... | 2,150 | 1,145 | .... | .... | 6,360 | 8,111 | 19 | .... | 11 | 14 |
| Asia and Oceania | 22,305 | 28,332 | 159 | 308 | 1,134 | 751 | 487 | 374 | 11 | 20 | 1,844 | 1,012 | 5,680 | 6,144 | 4,210 | 4,117 |
| British India | 3,799 | 3,761 | .... | 1 | .... | .... | .... | .... | 6 | 14 | 176 | 62 | 2,902 | 3,127 | 483 | 375 |
| China and Hong Kong | 7,576 | 14,444 | .... | 1 | 250 | 120 | 88 | 96 | .... | .... | 3 | 12 | .... | .... | 188 | 274 |
| Netherlands Indies | 1,596 | 1,281 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 573 | 871 | 628 | 143 |
| Japan | 6,984 | 6,117 | 159 | 306 | 881 | 629 | 369 | 174 | 4 | 6 | 1,585 | 807 | 1,216 | 921 | 2,031 | 2,409 |
| Africa | 1,137 | 1,446 | .... | .... | .... | .... | 117 | 169 | 5 | 9 | .... | 1 | 486 | 657 | 53 | 100 |
| Egypt | 503 | 779 | .... | .... | .... | .... | 18 | 9 | 3 | 8 | .... | .... | 385 | 627 | 28 | 52 |
| Algeria and Tunis and other French Africa | 375 | ..... | .... | .... | .... | .... | 99 | 160 | .... | .... | .... | .... | .... | 27 | 2 | 4 |

# How Nations Rank in Foreign Trade in Chemicals




**WORLD CHEMICAL TRADE**

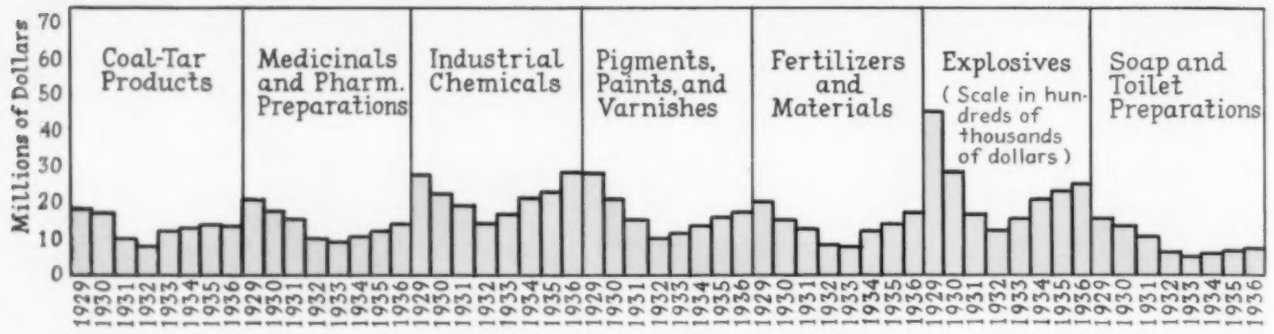
( In Millions of U.S. Dollars )

Data for 1934, last year figures available

| Imports Into | Country | Exports From |
|---|---|---|
| 100 | Germany | 252 |
| 97 | United States | 133 |
| 105 | United Kingdom | 123 |
| 76 | France | 112 |
| 378 | Total for Big Four | 620 |
| 46 | Belgium | 58 |
| 55 | Netherlands | 46 |
| 26 | Switzerland | 40 |
| 49 | Japan | 27 |
| 41 | Italy | 24 |
| 10 | Norway | 21 |
| 14 | U.S.S.R. | 20 |
| 23 | North Africa ( includes Algeria, Tunis, Morocco ) | 20 |
| 642 | Total for twelve countries | 876 |

Note: These data are taken from pages 14 and 15 of Trade Information Bulletin 832, "World Chemical Developments in 1935," by Concannon and Swift.

There are some countries having greater import trade than the twelve listed above. These twelve have been selected as those having the greatest export trade and are listed in the order of that item.

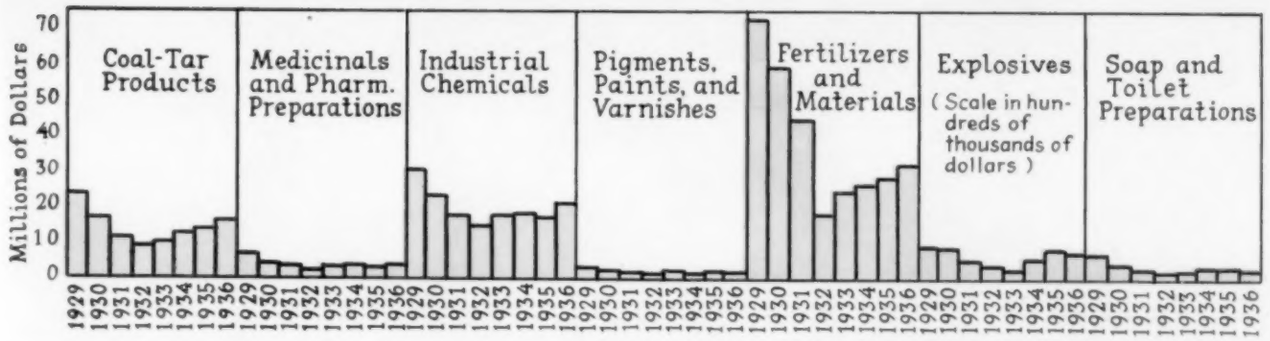



# UNITED STATES EXPORTS OF CHEMICALS

SOURCE. CHEMICAL DIVISION OF U. S. BUREAU

| | Quantity in Thousands (Pounds Except as Otherwise Specified) | | | | | | Value in Thousands of Dollars | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1921–1925 | 1926–1930 | 1929 | 1932 | 1935 | 1936* | 1921–1925 | 1926–1930 | 1929 | 1932 | 1935 | 1936* |
| GRAND TOTAL VALUE | ..... | ..... | ..... | ..... | ..... | ..... | $147,200 | $190,101 | $212,275 | $95,261 | $136,436 | $151,627 |
| Chemical and allied products (Group 8) | ..... | ..... | ..... | ..... | ..... | ..... | 107,564 | 134,914 | 152,109 | 70,403 | 130,092 | 112,762[2] |
| Coal-tar chemicals | | | | | | | | | | | | |
| Benzol (gals.) | 9,730 | 28,843 | 33,346 | 3,241 | 14,666 | 19,178 | 2,501 | 7,040 | 8,537 | 612 | 2,513 | 2,918 |
| Coal-tar pitch (tons) | ..... | ..... | 10 | 188 | 82 | 85 | ..... | ..... | 204 | 2,125 | 895 | 716 |
| Colors, dyes, stains | 16,948[1] | 30,074 | 34,130 | 16,097 | 19,631 | 17,408 | 5,392 | 6,300 | 7,279 | 4,071 | 6,873 | 6,081 |
| Other products, except medicinals | ..... | ..... | ..... | ..... | ..... | ..... | 1,776 | 2,631 | 2,041 | 1,944 | 3,317 | 4,061 |
| Medicinal and pharmaceutical preparations | ..... | ..... | ..... | ..... | ..... | ..... | 16,293 | 20,081 | 21,467 | 10,027 | 12,199 | 14,393 |
| Biologics (antitoxins, serums, vaccines, etc.) | ..... | ..... | ..... | ..... | ..... | ..... | 781[1] | 2,036 | 2,530 | 1,832 | 1,794 | 2,200 |
| Industrial chemical specialities | | | | | | | | | | | | |
| Insecticides, disinfectants, etc | ..... | 20,093 | 28,194 | 14,515 | 23,091 | 23,176 | ..... | 4,236 | 5,344 | 1,874 | 2,423 | 2,868 |
| Petroleum jelly | 8,136 | 6,976 | 7,073 | 10,199 | 14,817 | 22,177 | 1,216 | 901 | 926 | 611 | 799 | 1,085 |
| Water softeners, purifiers, etc | ..... | 3,092[2] | 3,264 | 1,610 | 2,351 | 2,710 | ..... | 365[2] | 394 | 217 | 274 | 319 |
| Metal working compounds | ..... | 1,809 | 2,240 | 700 | 1,846 | 2,082 | ..... | 275[2] | 336 | 110 | 182 | 215 |
| Other | ..... | ..... | ..... | ..... | ..... | ..... | 3,235 | 7,229 | 7,457 | 7,137 | 9,184 | 11,485 |
| Industrial chemicals | | | | | | | | | | | | |
| Acids and anhydrides | ..... | ..... | 27,417 | 19,742 | 28,344 | 31,998 | 1,188 | 1,133 | 1,264 | 628 | 1,117 | 1,446 |
| Alcohols | | | | | | | | | | | | |
| Methanol (gals.) | 788 | 540 | 498 | 770 | 619 | 668 | 732 | 367 | 403 | 324 | 300 | 283 |
| Glycerine | 1,963 | 1,099 | 1,374 | 260 | 3,354 | 1,146 | 325 | 179 | 198 | 29 | 450 | 183 |
| Other | ..... | 2,811 | 3,500 | 3,174 | 4,779 | 11,697 | 721 | 367 | 488 | 297 | 458 | 1,275 |
| Acetone | ..... | 5,500[2] | 7,897 | 4,404 | 2,884 | 5,636 | ..... | 402[2] | 708 | 318 | 296 | 456 |
| Formaldehyde | 2,744[1] | 2,670 | 2,588 | 2,103 | 2,498 | 1,844 | 320 | 221 | 225 | 101 | 134 | 89 |
| Nitro or aceto cellulose solutions, etc | ..... | 1,815[2] | 2,111 | 2,018 | 3,408 | 3,991 | ..... | 509[2] | 625 | 373 | 671 | 779 |
| Aluminum sulphate | 33,900 | 47,086 | 53,176 | 43,099 | 66,182 | 57,576 | 452[1] | 549 | 608 | 463 | 685 | 578 |
| Calcium carbide | 9,482 | 4,297 | 4,345 | 2,287 | 4,496 | 4,164 | 452 | 184 | 185 | 93 | 164 | 148 |
| Calcium chloride | ..... | 36,775[2] | 30,851 | 35,494 | 61,471 | 55,662 | ..... | 439[2] | 363 | 378 | 525 | 504 |
| Sodium compounds | 355,100[1] | 500,694 | 705,196 | 410,582 | 522,861 | 512,141 | 8,725 | 10,548 | 12,389 | 7,222 | 9,476 | 9,321 |
| Borate (borax) | 25,979 | 112,770 | 159,768 | 179,282 | 228,895 | 204,042 | 1,176 | 2,625 | 2,935 | 2,678 | 3,242 | 3,120 |
| Carbonate (soda ash, sal soda) | 43,055 | 68,348 | 90,404 | 33,318 | 89,336 | 90,047 | 936 | 1,269 | 1,535 | 545 | 1,139 | 1,095 |
| Hydroxide (caustic soda) | 100,872 | 114,211 | 122,045 | 110,977 | 139,137 | 153,912 | 3,400 | 3,363 | 3,566 | 2,360 | 2,999 | 3,082 |
| Gases, compressed and liquefied | ..... | 11,563[2] | 12,735 | 12,560 | 36,298 | 37,897 | ..... | 989[2] | 1,058 | 644 | 1,176 | 1,360 |
| Other industrial chemicals | ..... | ..... | ..... | ..... | ..... | ..... | 11,632 | 8,525 | 9,683 | 3,290 | 8,176 | 5,967 |
| Pigments, paints and varnishes | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 23,397 | 29,111 | 10,366 | 16,344 | 17,788 |
| Mineral earth pigments, etc | 28,944[1] | 39,014 | 41,960 | 15,448 | 47,431 | 55,653 | 925 | 923 | 863 | 286 | 473 | 569 |
| Carbon black, bone black and lamp black | 33,637[1] | 72,961 | 95,030 | 101,255 | 143,570 | 156,197 | 3,175 | 6,019 | 8,455 | 4,509 | 6,779 | 7,350 |
| Other chemical pigments | ..... | 57,854 | 69,339 | 20,851 | 22,766 | 23,662 | 2,788 | 4,130 | 5,277 | 1,441 | 2,006 | 2,253 |
| Nitrocellulose lacquers (gal.) | (3) | (3) | 558 | 510 | 1,172 | 1,500 | (3) | (3) | 1,695 | 983 | 1,750 | 2,167 |
| Other paints, stains, enamels | ..... | ..... | ..... | ..... | ..... | ..... | 6,476 | 9,740 | 11,454 | 2,788 | 4,836 | 4,858 |
| Varnishes (gal.) | 890 | 1,265[3] | 573 | 293 | 393 | 448 | 1,587 | 2,585[3] | 1,367 | 359 | 520 | 592 |
| Fertilizers and materials (tons long) | 1,028 | 1,336 | 1,534 | 847 | 1,484 | 1,649 | 17,472 | 17,917 | 20,441 | 8,653 | 14,509 | 17,751 |
| Ammonium sulphate (tons) | 129 | 128 | 145 | 15 | 78 | 106 | 7,924 | 6,046 | 6,296 | 408 | 2,040 | 2,682 |
| Other nitrogenous (tons) | 6[1] | 15 | 24 | 180 | 140 | 130 | 338[1] | 754 | 1,230 | 4,957 | 3,332 | 3,243 |
| Phosphate rock (tons) | 734 | 987 | 1,143 | 613 | 1,104 | 1,209 | 5,950 | 4,927 | 5,387 | 2,796 | 5,774 | 6,743 |
| Superphosphate (tons) | 37 | 91 | 85 | 24 | 55 | 68 | 516 | 1,429 | 1,489 | 259 | 534 | 688 |
| Other (tons) | 68 | 215 | 137 | 6 | 98 | 127 | 2,744 | 4,761 | 6,039 | 233 | 3,129 | 4,395 |
| Explosives and fuses | ..... | ..... | ..... | ..... | ..... | ..... | 3,892 | 4,072 | 4,549 | 1,281 | 2,439 | 2,618 |
| Dynamite | 14,560 | 13,840 | 16,277 | 4,607 | 9,846 | 12,253 | 2,270 | 1,964 | 2,228 | 600 | 1,261 | 1,568 |
| All other | ..... | ..... | ..... | ..... | ..... | ..... | 1,622 | 2,108 | 2,321 | 681 | 1,178 | 1,050 |
| Soap and toilet preparations | ..... | ..... | ..... | ..... | ..... | ..... | 15,505 | 15,998 | 16,061 | 6,422 | 7,208 | 8,075 |
| Soap, washing powders, etc | ..... | ..... | 74,540 | 34,917 | 27,123 | 30,558 | 8,853 | 8,118 | 7,277 | 2,847 | 2,584 | 2,729 |
| Dentifrices | 3,374[1] | 3,731 | 3,777 | 1,844 | 2,177 | 2,331 | 2,712[1] | 3 109 | 2,901 | 1,308 | 1,623 | 1,707 |
| Talcum and other toilet powders | ..... | ..... | ..... | ..... | ..... | ..... | 1,660[1] | 1,594 | 1,531 | 647 | 711 | 804 |
| Creams, rouges, etc | ..... | ..... | ..... | ..... | ..... | ..... | 1,144[1] | 2,078 | 2,048 | 792 | 1,142 | 1,516 |
| Other toilet preparations | ..... | ..... | ..... | ..... | ..... | ..... | 2,240 | 1,821 | 2,302 | 828 | 1,148 | 1,319 |
| Related products from other groups | ..... | ..... | ..... | ..... | ..... | ..... | 39,636 | 55,187 | 60,166 | 24,853 | 33,344 | 38,865 |
| Naval stores, gums and resins (bbls.) | | | | | | | | | | | | |
| Rosin | 1,038 | 1,270 | 1,437 | 1,098 | 1,195 | 1,196 | 11,278 | 20,008 | 20,442 | 6,255 | 9,994 | 11,236 |
| Spirits of turpentine (gal.) | 10,636 | 14,271 | 16,304 | 10,940 | 10,380 | 12,342 | 9,988 | 8,392 | 8,530 | 4,410 | 4,895 | 5,175 |
| Other gums | ..... | ..... | ..... | ..... | ..... | ..... | 1,113 | 1,866 | 2,025 | 922 | 1,609 | 2,513 |
| Crude drugs and botanicals | ..... | 5,074 | 4,683 | 3,852 | 4,775 | 4,712 | 3,174 | 3,341 | 3,690 | 1,193 | 1,195 | 1,871 |
| Essential oils | ..... | ..... | 6,043 | 4,722 | 11,100 | 2,112 | 1,208 | 2,223 | 2,436 | 1,311 | 2,679 | 2,339 |
| Linseed oil | 2,830 | 2,171 | 2,208 | 842 | 986 | 973 | 364 | 257 | 288 | 60 | 101 | 96 |
| Sulphur (tons) | 473 | 422 | 873 | 359 | 413 | 567 | 7,600 | 14,850 | 18,278 | 7,424 | ,001 | 10,894 |
| Pyroxylin products | | | | | | | | | | | | |
| Sheets, rods, tubes, scrap, film support | 2,909 | 3,255 | 3,945 | 4,471 | 5,808 | 5,276 | 2,998 | 1,974 | 2,190 | 2,607 | 3,791 | 3,393 |
| Manufactures | ..... | 1,151 | 1,022 | 127 | ..... | ..... | ..... | 1,266 | 1,136 | 199 | 249 | (4) |

*Preliminary. [1] Average years 1922–1925. [2] Average 1928–30. [3] Lacquers included with varnishes. [4] Not available.

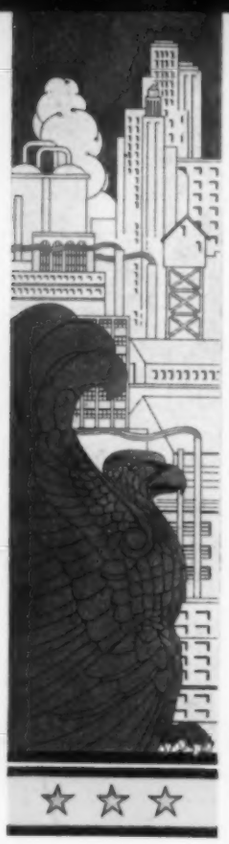



# UNITED STATES IMPORTS OF CHEMICALS

## OF FOREIGN AND DOMESTIC COMMERCE

| | Quantity in Thousands (Pounds Except as Otherwise Specified) | | | | | | Value in Thousands of Dollars | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1921–1925 | 1926–1930 | 1929 | 1932 | 1935 | 1936* | 1921–1925 | 1926–1930 | 1929 | 1932 | 1935 | 1936* |
| GRAND TOTAL, VALUE | ..... | ..... | ..... | ..... | ..... | ..... | $179,590 | $210,327 | $232,977 | $72,068 | $113,456 | $131,859 |
| Chemical and allied products (Group 8) | ..... | ..... | ..... | ..... | ..... | ..... | 112,100 | 132,811 | 144,062 | 47,852 | 69,720 | 78,244 |
| Coal-tar chemicals | ..... | ..... | ..... | ..... | ..... | ..... | 16,058 | 21,370 | 22,823 | 9,158 | 13,558 | 15,212 |
| Dead or creosote oil (gal.) | 62,713 | 83,608 | 79,301 | 29,300 | 34,513 | 41,384 | 8,701 | 11,802 | 10,119 | 2,647 | 3,537 | 4,566 |
| Other crudes | ..... | ..... | ..... | ..... | ..... | ..... | 889 | 1,403 | 2,051 | 577 | 1,224 | 2,072 |
| Intermediates | 2,554 | 2,940 | 3,962 | 1,769 | 2,062 | 2,327 | 658 | 1,194 | 1,646 | 786 | 2,447 | 2,485 |
| Colors, dyes, stains | 3,895 | 5,863 | 7,593 | 4,245 | 4,606 | 3,769 | 5,147 | 6,942 | 8,448 | 4,688 | 6,034 | 5,698 |
| Other finished products | ..... | 193 | 279 | 124 | 162 | 177 | 663 | 480 | 559 | 460 | 315 | 391 |
| Medicinal and pharmaceutical preparations | ..... | ..... | ..... | ..... | ..... | ..... | 4,917 | 5,573 | 6,422 | 2,530 | 4,128 | 4,890 |
| Industrial chemicals | ..... | ..... | ..... | ..... | ..... | ..... | 24,269 | 26,541 | 30,698 | 13,619 | 17,393 | 20,929 |
| Acetic acid | ..... | 25,806[1] | 29,235 | 13,976 | 35,096 | 28,278 | ..... | 1,808[1] | 2,117 | 843 | 2,079 | 1,518 |
| Arsenious (white arsenic) | 18,880[2] | 22,124 | 26,314 | 13,765 | 30,150 | 35,172 | 1,551[2] | 781 | 956 | 358 | 737 | 741 |
| Tartaric | 3,074[2] | 2,293 | 2,220 | 1,818 | 15 | 360 | 654[2] | 611 | 689 | 298 | 3 | 50 |
| Other acids and anhydrides | ..... | 42,756 | 20,741 | 3,092 | 4,369 | 5,318 | 1,385 | 1,931 | 658 | 215 | 480 | 827 |
| Ammonium compounds, n.e.s. | 16,254 | 22,741 | 20,030 | 11,060 | 11,995 | 13,420 | 865 | 849 | 697 | 269 | 309 | 344 |
| Cobalt oxide | 258[2] | 394 | 476 | 226 | 557 | 814 | 500[2] | 737 | 885 | 220 | 503 | 886 |
| Glycerine | 11,765 | 21,122 | 20,345 | 7,716 | 8,290 | 14,596 | 1,306 | 2,669 | 1,365 | 345 | 665 | 1,793 |
| Iodine | 304 | 696 | 627 | 632 | 376 | 592 | 847 | 2,330 | 2,249 | 2,226 | 421 | 558 |
| Potassium compounds | | | | | | | | | | | | |
| Bitartrate, crude, argols, wine lees | 20,054 | 19,890 | 18,001 | 18,108 | 16,368 | 16,806 | 1,436 | 1,872 | 2,113 | 996 | 903 | 911 |
| Carbonate | 8,530 | 16,502 | 22,644 | 10,457 | 4,125 | 2,795 | 368 | 759 | 1,024 | 429 | 232 | 151 |
| Nitrate (tons) | 4 | 10 | 13 | 17 | 40 | 59 | 274 | 459 | 546 | 831 | 1,244 | 1,701 |
| Other | 31,362 | 38,162 | 49,315 | 19,167 | 20,599 | 19,736 | 1,952 | 1,901 | 2,407 | 865 | 1,212 | 1,264 |
| Sodium cyanide | 22,802 | 33,686 | 40,047 | 17,585 | 26,540 | 27,179 | 1,982 | 2,668 | 3,199 | 1,729 | 2,930 | 2,901 |
| Sodium sulphate (salt cake) | ..... | ..... | 193,267 | 122,247 | 220,759 | 270,394 | ..... | ..... | 830 | 644 | 959 | 1,334 |
| Other sodium compounds | ..... | ..... | ..... | ..... | ..... | ..... | 1,439 | 2,099 | 3,167 | 1,274 | 730 | 1,193 |
| Other industrial chemicals | ..... | ..... | ..... | ..... | ..... | ..... | 9,710 | 5,067 | 7,796 | 2,077 | 3,986 | 4,757 |
| Pigments, paints, and varnishes | ..... | ..... | ..... | ..... | ..... | ..... | 3,080 | 3,556 | 3,822 | 1,445 | 2,109 | 1,971 |
| Fertilizers and materials | 1,613 | 2,152 | 2,318 | 869 | 1,334 | 1,461 | 57,139 | 67,997 | 72,340 | 18,689 | 27,317 | 31,693 |
| Ammonium sulphate (tons) | 9 | 24 | 19 | 307 | 79 | 153 | 479 | 1,003 | 763 | 5,410 | 1,760 | 3,269 |
| Calcium cyanamide (tons) | 60 | 132 | 184 | 63 | 100 | 113 | 3,043 | 4,862 | 6,221 | 1,628 | 2,359 | 2,622 |
| Sodium nitrate (tons) | 780 | 839 | 930 | 50 | 391 | 472 | 37,158 | 33,252 | 34,913 | 1,472 | 7,940 | 9,160 |
| Other nitrogenous (tons) | 85 | 204 | 193 | 72 | 181 | 244 | 2,856 | 9,088 | 8,509 | 1,851 | 4,436 | 5,877 |
| Phosphates (tons) | 41 | 101 | 105 | 67 | 44 | 49 | 1,084 | 2,178 | 2,149 | 942 | 753 | 931 |
| Potash fertilizers (tons) | | | | | | | | | | | | |
| Chloride, crude (tons) | 132 | 220 | 231 | 78 | 234 | 211 | 4,722 | 7,654 | 8,225 | 2,795 | 4,744 | 5,194 |
| Manure salts (tons) | 223 | 350 | 391 | 101 | 85 | 35 | 2,315 | 4,496 | 5,113 | 1,255 | 1,054 | 475 |
| Sulphate crude (tons) | 55 | 78 | 88 | 28 | 62 | 65 | 2,257 | 3,455 | 3,648 | 1,202 | 2,530 | 2,090 |
| Other (tons) | 165 | 139 | 77 | 50 | 74 | 53 | 1,346 | 1,784 | 653 | 460 | 592 | 531 |
| Other fertilizers (tons) | 50 | 65 | 100 | 53 | 84 | 66 | 1,598 | 225 | 2,146 | 844 | 1,150 | 1,554 |
| Explosives | ..... | ..... | ..... | ..... | ..... | ..... | 918 | 1,022 | 960 | 371 | 827 | 738 |
| Soap and toilet preparations | ..... | ..... | ..... | ..... | ..... | ..... | 7,076 | 6,739 | 6,988 | 2,038 | 3,388 | 2,811 |
| Soap | 4,731 | 6,706 | 7,030 | 4,762 | 22,442 | 3,920 | 772 | 1,127 | 1,263 | 578 | 1,162 | 540 |
| Perfume materials | ..... | ..... | ..... | ..... | ..... | ..... | 6,304 | 3,228 | 3,296 | 873 | 1,478 | 1,580 |
| Perfumery and toilet waters | ..... | ..... | ..... | ..... | ..... | ..... | | 1,659 | 1,504 | 342 | 562 | 515 |
| Other toilet preparations | ..... | ..... | ..... | ..... | ..... | ..... | | 732 | 925 | 245 | 186 | 176 |
| Other related products | ..... | ..... | ..... | ..... | ..... | ..... | 67,490 | 77,516 | 88,915 | 24,216 | 44,736 | 53,615 |
| Casein or lactarene | 17,421 | 25,045 | 27,583 | 1,201 | 3,230 | 16,209 | 1,916 | 2,979 | 3,323 | 38 | 262 | 1,369 |
| Naval stores, gums, resins | | | | | | | | | | | | |
| Varnish gums and resins | | | | | | | | | | | | |
| Damar | 20,864[3] | 15,369 | 19,131 | 8,553 | 15,005 | 15,708 | 2,846[3] | 1,969 | 2,403 | 344 | 783 | 903 |
| Lac, crude, seed etc. | ..... | 8,333[1] | 7,976 | 9,518 | 7,484 | 16,720 | ..... | 2,152[1] | 2,579 | 1,015 | 853 | 1,482 |
| Shellac | 27,183 | 26,554 | 33,335 | 11,321 | 20,054 | 14,878 | 14,958 | 9,820 | 12,789 | 1,511 | 2,736 | 1,723 |
| Other | 33,884[3] | 45,341 | 42,846 | 11,083 | 21,956 | 21,354 | 4,611[3] | 5,484 | 3,701 | 459 | 1,217 | 1,134 |
| Tar, pitch and turpentine | ..... | ..... | ..... | ..... | ..... | ..... | 200 | 341 | 335 | 103 | 227 | 233 |
| Camphor, natural, crude | 2,248 | 2,667 | 4,204 | 1,799 | 1,542 | 2,286 | 1,341 | 1,123 | 1,580 | 513 | 422 | 625 |
| Camphor, natural, refined | 2,691 | 1,258 | 1,431 | 1,034 | 1,256 | 1,049 | 1,758 | 706 | 793 | 358 | 499 | 470 |
| Camphor, synthetic | | 2,901 | 3,957 | 1,460 | 926 | 1,967 | | 1,171 | 1,376 | 406 | 321 | 637 |
| Chicle | 8,913 | 12,833 | 13,223 | 4,948 | 7,775 | 6,750 | 4,455 | 6,460 | 6,621 | 2,023 | 1,887 | 1,605 |
| Gum arabic | 8,034 | 8,657 | 8,471 | 5,509 | 7,955 | 8,424 | 842 | 870 | 913 | 227 | 622 | 619 |
| Other gums, resins, balsams | ..... | ..... | ..... | ..... | ..... | ..... | 1,856 | 2,805 | 2,547 | 954 | 1,428 | 1,715 |
| Crude drugs and botanicals | 86,734 | 116,216 | 130,754 | 91,481 | 107,857 | 116,428 | 6,527 | 9,474 | 10,582 | 5,005 | 7,594 | 6,905 |
| Pyrethrum flowers | 4,451[2] | 10,017 | 9,013 | 12,111 | 15,578 | 11,757 | 1,413 | 1,905 | 2,061 | 1,300 | 2,042 | 943 |
| Licorice root | 63,499 | 75,450 | 88,267 | 57,569 | 59,731 | 55,161 | 2,167 | 2,006 | 2,260 | 1,156 | 1,134 | 1,037 |
| Opium, crude | 105 | 136 | 168 | 130 | 88 | 171 | 502 | 880 | 1,071 | 274 | 407 | 709 |
| Other | 20,460 | 30,613 | 33,307 | 21,671 | 32,460 | 49,339 | 3,012 | 4,683 | 5,190 | 2,265 | 4,011 | 4,216 |
| Essential and distilled oils | ..... | ..... | ..... | ..... | ..... | ..... | 5,278 | 6,588 | 7,576 | 2,746 | 4,414 | 4,738 |
| Linseed oil | 54,836 | 5,649 | 9,961 | 25 | 2,232 | 760 | 4,326 | 414 | 739 | 1 | 91 | 31 |
| Tung oil | 75,354 | 105,575 | 119,678 | 75,922 | 120,059 | 134,830 | 9,247 | 12,367 | 14,972 | 3,434 | 13,131 | 17,838 |
| Pyroxylin, celluloid, pyralin, etc. | ..... | ..... | ..... | ..... | ..... | ..... | 1,217 | 2,461 | 2,713 | 591 | 242 | 350 |
| Matches | ..... | ..... | ..... | ..... | ..... | ..... | 1,963 | 2,276 | 3,435 | 922 | 418 | 341 |
| All other | ..... | ..... | ..... | ..... | ..... | ..... | 6,074 | 8,056 | 9,938 | 3,566 | 7,589 | 10,897 |

* Preliminary. [1] Average years 1929 and 1930. [2] Average years 1923–1925. [3] Includes kauri.



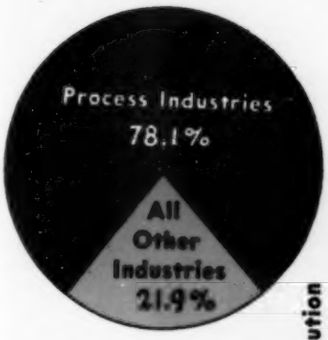
# COMMODITY MARKETS AND CHEMICAL CONSUMING INDUSTRIES

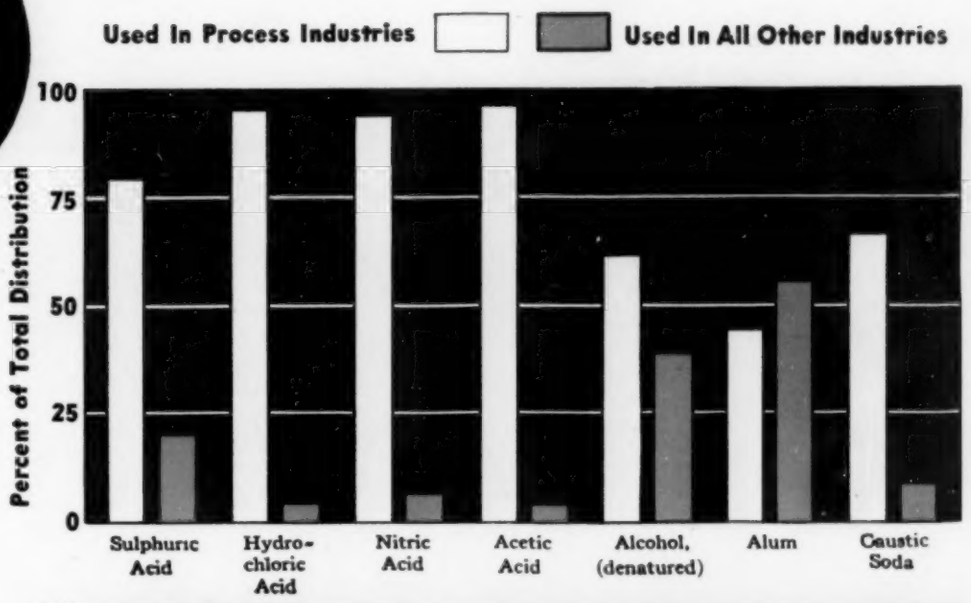
AMONG INDUSTRIES, chemical industry is unique in that it is its own best customer. In other words, the finished products of one branch of chemical industry become the raw materials for another—to such an extent that almost four-fifths of the output of the principal heavy chemicals is consumed within the process industries. As an example of this inter-relationship, consider acetic acid and the way in which this heavy chemical flows through and connects a group of quite different chemical activities.

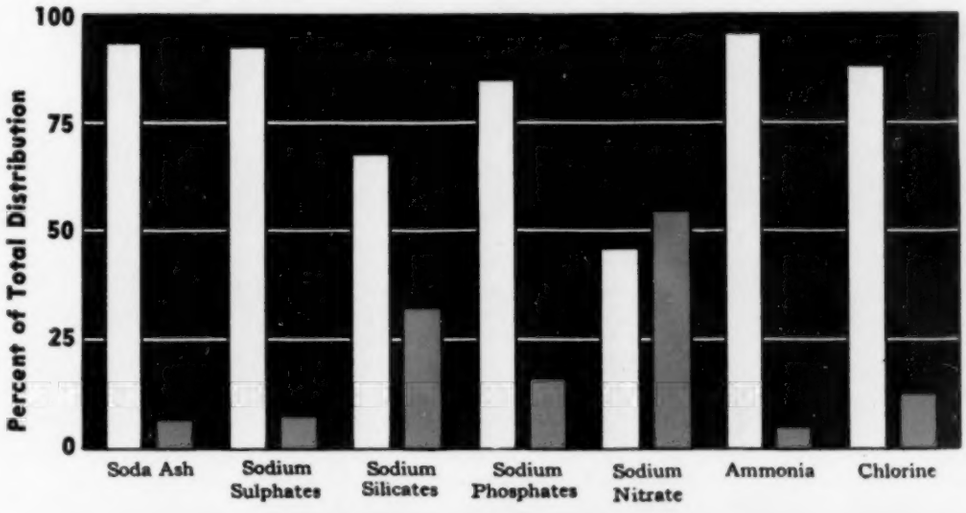
At Kingsport, Tenn., a wood-distillation plant recovers pyroligneous acid as one of its primary products. This crude acetic acid yields sodium acetate. From it acetic anhydride is made, only to be used in another unit of the same works for the manufacture of cellulose acetate. Some of this product is converted into rayon. From this operation there is a recovery of some weak acetic acid. This is then concentrated and shipped to an affiliated plant in another state where it is made into other acetic-acid derivatives. One of these is a transparent wrapping material which contains not only cellulose acetate but other acetates that serve as important conditioning agents. Thus acetic acid is the connecting link between industries quite as diverse as wood distillation, organic and inorganic chemical manufacture, and rayon, plastics, photography and transparent film-production.

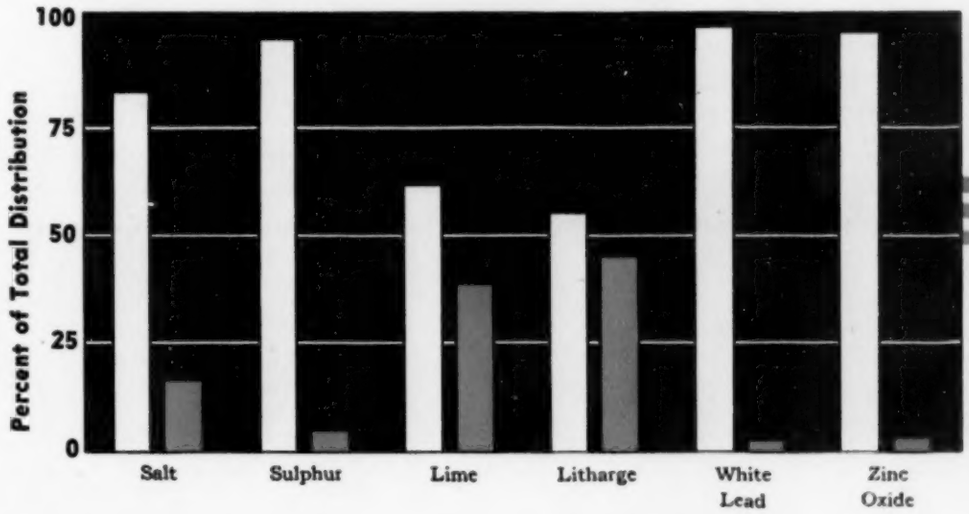
As you refer to the following pages of statistics, note how chemicals serve as common bonds between such apparently diverse process industries as salt and sugar, alkali and alcohol.

# CHEMICAL INDUSTRY
# ITS OWN BEST CUSTOMER



# COMMODITY MARKETS IN

## CHEMICALS

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 570 |
| Wage earners (ave. for yr.) | 65,876 |
| Wages | $80,480,665 |
| Cost of materials, fuel, and purchased electric energy | 329,391,117 |
| Value of products | 668,697,448 |
| Value added by manufacture | 339,306,331 |

## COMPRESSED AND LIQUEFIED GASES

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 330 |
| Wage earners (ave. for yr.) | 3,788 |
| Wages | $4,408,205 |
| Cost of materials, fuel, and purchased electric energy | 11,246,281 |
| Value of products | 41,018,951 |
| Value added by manufacture | 30,770,670 |

## INDUSTRIAL AND HOUSEHOLD CHEMICALS

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 546 |
| Wage earners (ave. for yr.) | 3,466 |
| Wages | $3,401,387 |
| Cost of materials, fuel, and purchased electric energy | 24,363,531 |
| Value of products | 53,429,197 |
| Value added by manufacture | 29,065,666 |

### Acids

| Product | | 1935 | 1933 |
|---|---|---|---|
| Acetic, basis 100% | lb. | 98,697,347 | 65,150,478 |
| | value | $9,945,243 | $4,302,881 |
| Boric | lb. | 28,506,000 | 21,612,634 |
| | value | $1,237,555 | $844,564 |
| Carbonic | lb. | 86,986,431 | 117,382,256 |
| | value | $4,011,956 | $4,466,461 |
| Chromic | lb. | 6,724,304 | 4,969,047 |
| | value | $887,842 | $537,378 |
| Citric | lb. | 10,493,068 | 5,695,793 |
| | value | $2,768,377 | $1,795,382 |
| Hydrochloric, basis 100% | tons | 87,090 | 62,628 |
| For sale | tons | 54,889 | 44,895 |
| | value | $3,048,159 | $2,386,790 |
| Hydrofluoric, basis 100% | lb. | 2,972,161 | 2,037,787 |
| | value | $468,178 | $320,634 |
| Mixed (Sulphuric-Nitric) | tons | 46,074 | 41,962 |
| | value | $2,105,231 | $1,883,320 |
| Nitric, basis 100% | tons | 122,596 | 100,414 |
| For sale | tons | 24,505 | 32,839 |
| | value | $2,142,817 | $2,959,013 |
| Oleic | lb. | 43,753,984 | [1] |
| | value | $3,272,536 | ..... |
| Oxalic | lb. | 8,883,521 | 9,223,062 |
| | value | $945,215 | $903,254 |
| Phosphoric | lb. | 44,917,991 | 24,652,505 |
| | value | $1,335,354 | $891,563 |
| Stearic | lb. | 27,426,289 | [1] |
| | value | $2,776,396 | ..... |
| Sulphuric basis 50° Be. | tons | 6,402,212 | [1] |
| For sale | tons | 4,470,469 | 3,847,889 |
| | value | $31,907,806 | $26,482,063 |
| Tannic | lb. | 724,552 | 682,462 |
| | value | $304,728 | $236,125 |
| Tartaric | lb. | 6,887,101 | 6,798,855 |
| | value | $1,609,027 | $1,492,871 |
| Hydrocyanic | lb. | 1,905,027 | [1] |
| | value | $954,219 | ..... |
| Other acids | value | $2,966,413 | $5,974,442 |
| All acids | value | $72,687,052 | $55,486,741 |

### Compressed and liquefied gases

| | | | |
|---|---|---|---|
| Ammonia, anhydrous | lb. | 138,245,032 | 150,184,618 |
| | value | $5,674,063 | $5,930,049 |
| Chlorine | tons | 319,303 | 217,089 |
| For sale | tons | 207,159 | 124,563 |
| | value | $7,944,266 | $4,486,325 |
| Hydrogen | 1,000 cu. ft. | 743,860 | 589,290 |
| | value | $1,556,658 | $914,532 |
| Acetylene | 1,000 cu. ft. | 1,133,824 | 754,089 |
| | value | $14,747,854 | $11,038,959 |
| Liquefied petroleum gases | 1,000 gal. | 381,738 | 178,630 |
| | value | $7,980,298 | $2,524,098 |
| Other hydrocarbon gases | value | $501,338 | $1,216,859 |
| Nitrous oxide | 1,000 gal. | 95,861 | 82,220 |
| | value | $945,802 | $810,529 |
| Oxygen | 1,000 cu. ft. | 2,675,396 | 1,821,880 |
| | value | $18,115,968 | $12,997,005 |
| Sulphur dioxide | lb. | 24,628,183 | 19,559,779 |
| | value | $1,170,401 | $967,657 |
| Carbon dioxide (not dry ice) | lb. | 87,407,476 | 117,382,256 |
| | value | $4,528,449 | $4,466,461 |
| Solid carbondioxide (dry ice) | lb. | 165,123,912 | 59,057,600 |
| | value | $3,245,692 | $1,969,526 |
| Other gases | value | $677,549 | $863,381 |
| All gases | value | $42,018,951 | $32,007,108 |

### Miscellaneous chemicals

| Product | | 1935 | 1933 |
|---|---|---|---|
| Acetates — Aluminum | tons | 175 | 76 |
| | value | $30,285 | $11,295 |
| Amyl | gal. | 1,025,789 | 608,000 |
| | value | $789,293 | $441,592 |
| Butyl | gal. | 5,631,056 | 3,763,176 |
| | value | $3,686,689 | $2,577,547 |
| Calcium | tons | 25,860 | 26,042 |
| | value | $831,356 | $1,165,938 |
| Ethyl | gal. | 5,563,199 | 5,082,213 |
| | value | $2,679,195 | $2,660,445 |
| Chromium | lb. | 630,023 | [1] |
| | value | $35,171 | ..... |
| Lead | lb. | 3,360,067 | [1] |
| | value | $252,799 | ..... |
| Other acetates | value | $4,909,025 | $4,307,792 |
| Chromates and bichromates Sodium | tons | 37,110 | 29,234 |
| | value | $4,267,266 | $3,280,994 |
| Potassium | lb. | 4,491,316 | [1] |
| | value | $359,366 | ..... |
| Other chromates and bichromates | value | $141,584 | $298,310 |
| Citrates | value | $1,358,161 | $1,463,463 |
| Cyanides — copper | lb. | 473,518 | 551,599 |
| | value | $169,557 | $209,117 |
| Ferric-ferro | lb. | 4,894,621 | [1] |
| | value | $1,742,069 | ..... |
| Other cyanides | value | $5,081,965 | $4,657,497 |
| Hydroxides — Potassium | tons | 9,518 | 9,348 |
| | value | $1,260,031 | $868,000 |
| Sodium | tons | 758,543 | 686,983 |
| For sale | tons | 719,456 | 644,731 |
| | value | $28,104,631 | $24,478,385 |
| Other Hydroxides | value | $882,984 | $660,142 |
| Iodides | value | $745,324 | $1,309,237 |
| Nitrates — Ammonium | lb. | 25,297,894 | 18,693,952 |
| | value | $673,704 | $574,056 |
| Silver | ounces | 5,144,507 | 4,145,648 |
| | value | $1,887,693 | $1,071,810 |
| Other nitrates | value | $735,432 | $958,073 |
| Resinates | value | $171,994 | $69,830 |
| Stearates | value | $1,085,219 | [1] |
| Salicylates | value | $200,805 | $135,841 |
| Sulphides — Sodium | tons | 24,757 | 30,732 |
| | value | $1,362,698 | $1,353,886 |
| Ammonium, basis 100% | lb. | 848,218 | [1] |
| | value | $85,730 | ..... |
| Other sulphides | value | $635,721 | $436,560 |
| Sulphites — Sodium, normal | tons | 6,840 | 3,371 |
| | value | $473,991 | $266,339 |
| Sodium-formaldehyde and zinc-hypo | lb. | 15,076,836 | 12,482,486 |
| | value | $2,650,638 | $2,305,059 |
| Other sulphites | value | $620,405 | $431,690 |
| Tartrates | value | $867,883 | $1,088,252 |
| Bicarbonate and carbonates Sodium bicarbonate, basis 100% | tons | 136,556 | 129,273 |
| | value | $3,658,321 | $3,585,862 |
| Copper carbonate | lb. | 337,236 | 525,570 |
| | value | $89,536 | $77,724 |
| Soda ash | tons | 2,508,859 | 2,317,011 |
| For sale | tons | 1,871,635 | 1,654,028 |
| | value | $28,424,750 | $24,182,681 |
| Calcium carbonate | tons | 33,921 | [1] |
| | value | $859,649 | ..... |
| Magnesium carbonate | tons | 7,301 | [1] |
| | value | $877,741 | ..... |

## ESTIMATED CONSUMPTION OF CHEMICALS

### Alkalis

*Soda Ash*

| | |
|---|---|
| 3,910,000 tons | Salt (in brine) |
| 3,135,000 tons | Limestone |
| 2,150 tons | Ammonia |

*Lime Soda Caustic*

| | |
|---|---|
| 590,000 tons | Soda Ash |
| 700,000 tons | Limestone |

*Electrolytic Caustic Soda*

| | |
|---|---|
| 514,000 tons | Salt (mined or brine) |
| 8,000 tons | Soda Ash |
| 48,000 tons | Sulphuric Acid (50°) |

*Bicarbonate of Soda*

| | |
|---|---|
| 86,000 tons | Soda Ash |

### Mineral Acids

*Sulphuric Acid*

| | |
|---|---|
| 848,000 tons | Sulphur |
| 565,000 tons | Domestic Pyrites |
| 445,000 tons | Imported Pyrites |
| 325,000 tons | Sulphur Dioxide |
| 3,900 tons | Anhydrous Ammonia |
| 5,400 tons | Sodium Nitrate |

*Nitric Acid*

| | |
|---|---|
| 17,400 tons | Sodium Nitrate |
| 32,000 tons | Sulphuric Acid (50°) |
| 41,000 tons | Anhydrous Ammonia |

*Hydrochloric Acid*

| | |
|---|---|
| 104,000 tons | Salt |
| 139,000 tons | Sulphuric Acid (50°) |

# CHEMICAL CONSUMING INDUSTRIES

## WOOD DISTILLATION AND CHARCOAL

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 60 |
| Wage earners (ave. for yr.) | 3,808 |
| Wages | $2,816,417 |
| Cost of materials, fuel, and purchased electric energy | 7,944,083 |
| Value of products | 15,970,917 |
| Value added by manufacture | 8,026,834 |

## BONE BLACK, CARBON BLACK, AND LAMPBLACK

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 55 |
| Wage earners (ave. for yr.) | 1,828 |
| Wages | $1,936,570 |
| Cost of materials, fuel, and purchased electric energy | 5,334,329 |
| Value of products | 14,811,298 |
| Value added by manufacture | 9,476,969 |

## MANUFACTURED GAS

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 520 |
| Wage earners (ave. for yr.) | 19,741 |
| Wages | $27,663,273 |
| Cost of materials, fuel, and purchased electric energy | 97,861,327 |
| Value of products | 345,967,324 |
| Value added by manufacture | 248,105,997 |

| Miscellaneous Chemicals—Continued | | 1935 | 1933 |
|---|---|---|---|
| Potassium carbonate | lb. | 11,712,225 | 1 |
| | value | $643,164 | ..... |
| Sal soda | tons | 39,439 | 1 |
| | value | $1,021,308 | ..... |
| Other bicarbonates and carbonates | value | $1,092,644 | $2,334,222 |
| Chlorides | total value | $16,861,430 | $15,746,841 |
| Aluminum | tons | 2,339 | 1,127 |
| | value | $397,295 | $143,250 |
| Calcium, basis 73–75% | tons | 227,001 | 158,000 |
| | value | $3,628,888 | $2,715,552 |
| Ferric and ferrous | lb. | 11,310,416 | 9,153,567 |
| | value | $291,875 | $201,253 |
| Sulphur | lb. | 76,362,340 | 45,997,960 |
| | value | $1,178,804 | $664,983 |
| Stannic and stannous | lb. | 16,117,992 | 19,190,188 |
| | value | $4,151,298 | $3,326,947 |
| Ammonia | lb. | 28,015,734 | 1 |
| | value | $1,242,261 | ..... |
| Other chlorides | value | $5,971,009 | $8,694,856 |
| Oxalates | value | $148,984 | $99,189 |
| Oxides | total value | $9,867,831 | $4,489,223 |
| Aluminum | tons | 22,035 | 7,664 |
| | value | $3,852,141 | $1,525,141 |
| Tin | lb. | 3,245,462 | 2,743,179 |
| | value | $1,685,692 | $1,117,545 |
| Peroxides, total | value | $3,856,375 | $2,979,361 |
| Hydrogen, basis 100 vol. | lb. | 17,409,092 | 12,118,806 |
| | value | $3,154,593 | $2,388,229 |
| Phosphates, total | value | $14,189,220 | $11,317,643 |
| Calcium | tons | 40,591 | 42,246 |
| | value | $5,115,584 | $5,331,999 |
| Sodium | tons | 132,206 | 120,458 |
| | value | $6,552,095 | $5,620,439 |
| Other phosphates | value | $2,521,540 | $365,255 |
| Sulphates | total value | $21,404,993 | $16,825,816 |
| Aluminum | tons | 353,217 | 326,500 |
| | value | $8,007,782 | $6,798,810 |
| Barium | lb. | 10,550,507 | 8,676,391 |
| | value | $317,004 | $261,035 |
| Copper | lb. | 54,395,039 | 56,070,199 |
| | value | $1,911,099 | $1,407,631 |
| Iron | tons | 31,852 | 27,860 |
| | value | $311,516 | $252,575 |
| Magnesium | tons | 38,489 | 37,364 |
| | value | $1,116,534 | $1,234,342 |
| Sodium | tons | 286,051 | 203,183 |
| | value | $4,262,546 | $3,173,332 |
| Sodium-aluminum | tons | 18,040 | 18,941 |
| | value | $1,030,415 | $1,019,849 |
| Zinc | lb. | 37,006,565 | 29,796,852 |
| | value | $721,025 | $512,103 |

### Miscellaneous inorganics

| Product | | 1935 | 1933 |
|---|---|---|---|
| Ammonia, aqua and liquor, $NH_3$ content | lb. | 17,173,768 | 11,390,067 |
| | value | $1,075,036 | $923,125 |
| Calcium carbide | tons | 147,092 | 101,488 |
| | value | $6,234,380 | $6,059,205 |
| Calcium oxychloride | tons | 39,561 | 28,302 |
| | value | $909,071 | $921,264 |
| Sodium borate | tons | 106,137 | 93,813 |
| | value | $3,694,629 | $3,163,335 |
| Sodium hypochlorite | tons | 50,807 | 32,468 |
| | value | $4,728,921 | $2,073,133 |
| Modified sodas | tons | 29,103 | 21,873 |
| | value | $1,140,022 | $775,805 |

| Miscellaneous Inorganics—Continued | | 1935 | 1933 |
|---|---|---|---|
| Sodium silicate | | | |
| Liquid, basis 40% | tons | 648,827 | ..... |
| | value | $6,607,204 | $630,367 |
| Solid | tons | 30,536 | $6,582,613 |
| | value | $1,065,968 | 1 |
| Sulphur refined | tons | 47,504 | 48,663 |
| | value | $1,649,758 | $1,736,064 |

### Miscellaneous organic chemicals

| | | | |
|---|---|---|---|
| Coal-tar crudes | value | $19,173,000 | $16,984,752 |
| Coal-tar intermediates | value | $29,321,950 | $21,443,027 |
| Coal-tar finished products | value | $72,997,015 | $68,844,954 |
| Alcohols-methyl, synthetic | gal. | 13,359,247 | |
| | value | $3,611,382 | |
| Amyl | lb. | 5,160,604 | |
| | value | $568,111 | $24,082,464 |
| Butyl | lb. | 35,877,675 | |
| | value | $2,601,983 | |
| Ethyl and other alcohols | value | $31,382,286 | |
| Carbon bisulphide | lb. | 117,757,762 | 90,179,039 |
| | value | $3,309,644 | $3,282,612 |
| Carbon tetrachloride | lb. | 51,970,367 | 30,343,693 |
| | value | $2,149,877 | $1,354,475 |
| Ether, ethyl | lb. | 7,915,299 | 7,421,283 |
| | value | $1,305,459 | $1,384,694 |
| Glycerine, crude | lb. | 24,041,800 | 22,161,409 |
| | value | $2,366,481 | $1,191,000 |
| Glycerine, refined | lb. | 121,261,514 | 107,852,796 |
| | value | $12,984,684 | $7,915,000 |
| Acetone | lb. | 68,921,870 | 1 |
| | value | $2,642,149 | ..... |
| Ester Gum | lb. | 21,327,225 | 1 |
| | value | $1,481,880 | ..... |

### Bone black, carbon black, lamp black

| | | | |
|---|---|---|---|
| Bone black | lb. | 31,847,653 | 23,122,671 |
| | value | $1,259,584 | $828,596 |
| Carbon black | lb. | 352,749,000 | 273,125,000 |
| | value | $13,755,000 | $7,602,000 |
| Lamp black | lb. | 3,581,429 | 3,012,226 |
| | value | $333,439 | $210,054 |

### Wood distillation products

| | | | |
|---|---|---|---|
| Methanol, crude | gal. | 5,045,102 | 4,283,652 |
| For sale | gal. | 1,948,606 | 2,102,379 |
| | value | $315,753 | $288,456 |
| Methanol refined | gal. | 3,648,180 | 2,737,046 |
| | value | $1,148,548 | $884,531 |
| Acetate of lime | tons | 25,846 | 25,796 |
| | value | $825,522 | $869,771 |
| Miscellaneous wood chemicals | value | $1,889,796 | $1,719,259 |
| Tar | gal. | 9,983,934 | 6,051,122 |
| For sale | gal. | 3,370,781 | 1,858,486 |
| | value | $544,560 | $224,635 |
| Tar oils | gal. | 1,087,492 | 858,542 |
| | value | $194,261 | $119,339 |
| Turpentine, wood | gal. | 4,611,641 | 3,150,490 |
| | value | $1,853,925 | $1,031,188 |
| Pine oil | gal. | 3,443,315 | 2,149,565 |
| | value | $1,525,938 | $1,014,259 |
| Rosin, wood | bbl. | 529,001 | 333,512 |
| | value | $4,171,862 | $1,904,730 |
| Charcoal | bu. | 34,157,752 | 1 |
| For sale | bu. | 26,888,616 | 22,912,468 |
| | value | $3,063,200 | $3,146,500 |
| Other wood products | value | $3,287,766 | $3,431,491 |

## ESTIMATED CONSUMPTION OF CHEMICALS

| | | | | | |
|---|---|---|---|---|---|
| 16,900 tons | Chlorine | 5,316,620 gal. | Pineapple Juice | 26,000 tons | Mixed Acid |
| 500 tons | Hydrogen | 1,190,183 gal. | Fermented Liquor | 17,000 tons | Nitric Acid (40°) |
| 5,000 tons | Niter Cake | 1,850 lb. | Miscellaneous | 25,500 tons | Soda Ash |
| | | | | 207,000 tons | Sodium Chloride |
| | | | Organic Chemicals | 210,000 tons | Sulphuric Acid (50°) |
| | Ethyl Alcohol | | | 10,250 tons | Zinc Dust |
| | | 4,250 tons | Ammonia Anhydrous | | |
| 187,849,299 gal. | Molasses | 75,500 tons | Caustic Soda | | |
| 65,922,466 lb. | Corn | 79,000 tons | Chlorine (100%) | | Byproduct Coke |
| 14,134,676 lb. | Malt | 80,500 tons | Hydrochloric Acid (18 deg.) | 49,000,000 tons | Bituminous Coal |
| 3,837,630 lb. | Rye | | | 577,000 tons | Sulphuric Acid (50°) |
| 13,698,550 gal. | Ethyl Sulphate | 17,000 tons | Lime | 50,000 tons | Lime |
| 28,245,237 lb. | Hydrol | 15,000 tons | Acetylene | | |

# COMMODITY MARKETS IN

## PAINT AND VARNISH

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 1,082 |
| Wage earners (ave. for yr.) | 27,686 |
| Wages | $32,186,867 |
| Cost of materials, fuel, and purchased electric energy | $231,982,952 |
| Value of products | $416,999,566 |
| Value added by manufacture | $185,016,614 |

## EXPLOSIVES

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 74 |
| Wage earners (ave. for yr.) | 4,566 |
| Wages | $5,639,358 |
| Cost of materials, fuel, and purchased electric energy | $17,000,618 |
| Value of products | $40,667,200 |
| Value added by manufacture | $23,666,582 |

## PETROLEUM REFINING

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 394 |
| Wage earners (ave. for yr.) | 77,402 |
| Wages | $109,714,355 |
| Cost of materials, fuel, and purchased electric energy | $1,478,224,853 |
| Value of products | $1,838,621,913 |
| Value added by manufacture | $360,397,060 |

### Paint and Varnish

| Product | | 1935 | 1931 [1] |
|---|---|---|---|
| Water paints and calcimines: | lb. | 123,620,763 | 122,823,417 |
| | value | $5,164,593 | $5,265,219 |
| Plastic paints: | lb. | 18,027,105 | 14,561,624 |
| | value | $1,218,625 | $1,393,044 |
| Paints in paste form, total: | lb. | 236,238,350 | 242,528,011 |
| | value | $23,207,858 | $26,190,760 |
| White lead in oil: | lb. | 105,118,150 | 180,723,473 |
| | value | $15,294,514 | $16,704,948 |
| Red lead in oil: | lb. | 3,428,497 | 4,222,648 |
| | value | $306,023 | $461,797 |
| Zinc oxide in oil: | lb. | 1,246,833 | 2,582,567 |
| | value | $113,819 | $301,182 |
| Colors in oil: | lb. | 19,931,818 | 23,836,847 |
| | value | $3,707,026 | $4,674,255 |
| Colors in japan: | lb. | 1,294,393 | 1,520,880 |
| | value | $374,332 | $483,681 |
| Other paste paints: | lb. | 35,218,659 | 29,641,587 |
| | value | $3,442,144 | $3,564,887 |
| Ready-mixed and semi-paste paints, totals: | gal. | 80,449,713 | 81,286,734 |
| | value | $128,830,840 | $125,112,458 |
| Paints in oil, ready mixed: | gal. | 39,621,507 | 37,709,502 |
| | value | $63,458,416 | $63,523,576 |
| Undercoatings and primers: | gal. | 8,649,029 | 6,764,541 |
| | value | $10,167,329 | $9,237,455 |
| Wall paints and mill whites: | gal. | 21,451,206 | 15,933,339 |
| | value | $30,267,683 | $24,361,397 |
| Stains (not incl. varnish stains): | gal. | 3,077,151 | 3,037,679 |
| | value | $3,308,561 | $3,956,778 |
| Other ready-mixed and semi-paste: | gal. | 16,650,820 | 17,841,673 |
| | value | $21,628,860 | $24,033,252 |
| Varnishes, resinous: | gal. | 30,378,757 | 27,074,157 |
| | value | $32,146,023 | $29,870,415 |
| Varnishes, spirit, not turpentine: | gal. | 7,908,191 | 5,887,607 |
| | value | $8,663,744 | $7,423,559 |
| Other varnishes: | gal. | 8,622,674 | 5,396,483 |
| | value | $8,767,907 | $5,990,923 |
| Varnish stains: | gal. | 1,763,515 | 1,726,151 |
| | value | $2,932,682 | $2,542,476 |
| Clear lacquers: | gal. | 9,332,624 | 8,096,582 |
| | value | $12,860,955 | $12,846,124 |
| Pigmented lacquers: | gal. | 11,760,134 | 8,705,436 |
| | value | $25,367,609 | $20,734,704 |
| Thinners: | gal. | 18,591,545 | 12,701,400 |
| | value | $12,864,123 | $11,271,917 |
| Lacquer bases and dopes: | gal. | 2,654,763 | [2] |
| | value | $3,232,814 | $2,328,406 |
| Other nitrocellulose products: | value | $1,971,123 | |
| Enamels: | gal. | 31,461,148 | 15,478,029 |
| | value | $55,095,886 | $29,798,701 |
| Drying japans, baking japans, and driers: | gal. | 5,373,264 | 4,869,984 |
| | value | $3,856,467 | $3,860,745 |
| Other varnish products: | value | $3,007,280 | $1,184,259 |
| Fillers — Liquid: | gal. | 292,956 | 204,311 |
| | value | $342,588 | $235,674 |
| Paste: | lb. | 8,201,690 | 13,242,997 |
| | value | $617,798 | $828,731 |
| Dry: | lb. | 8,978,373 | 6,243,410 |
| | value | $198,158 | $146,498 |
| Putty: | lb. | 71,783,976 | 69,907,186 |
| | value | $2,869,865 | $2,992,484 |
| Bleached shellac: | lb. | 12,524,732 | 10,731,259 |
| | value | $2,425,032 | $2,619,073 |

[1] No comparable data available for 1933 due to changes in census classification.
[2] Data incomplete.

### Petroleum Refining

| Product | | 1935 | 1933 |
|---|---|---|---|
| Light products of distillation (except tops), total: | gal. | 18,766,014,735 | 16,354,817,643 |
| | value | $1,039,387,999 | $773,181,965 |
| Gasoline: | gal. | 18,505,867,347 | 16,094,530,726 |
| | value | $1,023,587,576 | $759,183,108 |
| Naphtha: | gal. | 216,906,289 | 228,515,546 |
| | value | $13,223,238 | $12,251,380 |
| Benzine: | gal. | 43,241,099 | 31,771,371 |
| | value | $2,577,185 | $1,747,479 |
| Illuminating oils: | gal. | 2,194,731,494 | 1,949,862,606 |
| | value | $94,178,808 | $78,127,721 |
| Fuel oils, total: | gal. | 15,905,205,577 | 13,295,106,853 |
| | value | $359,437,322 | $253,236,655 |
| Distillates: | gal. | 1,782,051,447 | 1,598,816,084 |
| | value | $60,982,655 | $49,617,648 |
| Gas oils: | gal. | 2,709,137,970 | 1,977,442,889 |
| | value | $85,549,854 | $53,930,839 |
| Residual fuel oils: | gal. | 11,414,016,160 | 9,718,847,880 |
| | value | $212,904,813 | $149,658,168 |
| Partially refined oils sold for rerunning: | gal. | 1,042,275,771 | 1,130,067,737 |
| | value | $31,658,293 | $23,733,608 |
| Lubricating oils: | gal. | 1,274,384,495 | 1,047,211,662 |
| | value | $186,533,605 | $142,444,081 |
| Liquid asphaltic road oils: | gal. | 406,967,817 | 300,243,118 |
| | value | $13,346,322 | $8,343,122 |
| Greases, total: | gal. | 49,918,651 | 41,923,024 |
| | value | $12,739,929 | $9,250,944 |
| Petrolatum, mineral jelly, etc: | gal. | 18,327,253 | 14,710,994 |
| | value | $2,607,820 | $1,854,740 |
| Lubricating greases, including axle grease: | gal. | 31,591,398 | 27,212,030 |
| | value | $10,132,109 | $7,396,204 |
| Paraffin wax: | gal. | 61,200,766 | 72,851,936 |
| | value | $11,000,554 | $12,210,791 |
| Acid oil: | gal. | 64,664,056 | 85,627,032 |
| | value | $826,807 | $1,014,729 |
| Asphalt other than liquid: | tons | 1,962,272 | 1,789,798 |
| | value | $20,820,007 | $17,931,591 |
| Petroleum coke: | tons | 1,441,684 | 1,751,412 |
| | value | $5,756,638 | $5,581,928 |
| Other refinery products (including tops): | value | $54,708,159 | $32,940,326 |

### Explosives

| Product | | 1935 | 1933 |
|---|---|---|---|
| Explosives, total: | lb. | 337,978,213 | 288,407,846 |
| | value | $34,645,759 | $29,045,482 |
| Dynamite: | lb. | 191,190,664 | 147,844,610 |
| | value | $19,715,009 | $15,222,725 |
| Permissible explosives [1] | lb. | 47,990,826 | 51,560,267 |
| | value | $4,985,657 | $4,153,927 |
| Nitroglycerine for shooting wells on contract and made for sale: | lb. | 2,483,262 | 1,111,011 |
| | value | $818,748 | $450,970 |
| Blasting powder: | lb. | 35,153,125 | |
| | value | $2,147,814 | 66,188,125 |
| Pellet powder: | lb. | 31,467,150 | $4,056,386 |
| | value | $2,076,261 | |
| Fuse powder: | lb. | 1,477,975 | 992,439 |
| | value | $231,654 | $186,092 |
| Gunpowder, black and smokeless, and other explosives not specified above | lb. | 28,215,211 | 20,711,394 |
| | value | $4,670,616 | $4,975,382 |

[1] Those approved by the Bureau of Mines, Department of the Interior, as suitable for use in mines where dust and gas explosions are likely to occur.

## ESTIMATED CONSUMPTION OF CHEMICALS

### Paint and Varnish

| | | |
|---|---|---|
| 4,480 | Tons | Sulphur |
| 3,275 | Tons | Carbon Black |
| 124,615 | Tons | Lithopone |
| 29,632 | Tons | Leaded Zinc Oxide |
| 25,289 | Tons | Zinc Oxide |
| 91,297 | Tons | White Lead |
| 7,770 | Tons | Basic Lead Sulphate |
| 8,721 | Tons | Red Lead |

### Explosives

| | | |
|---|---|---|
| 6,500 | Tons | Sulphur |
| 5,100 | Tons | Charcoal |
| 65,970 | Tons | Sodium Nitrate |
| 31,417 | Tons | Nitroglycerine |
| 644 | Tons | Nitrotoluol |
| 333 | Tons | Nitrocellulose |
| 23,489 | Tons | Ammonium Nitrate |
| 798 | Tons | Antacid |

### Petroleum Refining

| | | |
|---|---|---|
| 1,000,000 | Tons | Sulphuric Acid (50 deg.) |
| 90,000 | Tons | Caustic Soda |
| 8,000 | Tons | Soda Ash |
| 206,000 | Tons | Fuller's Earth |
| 100,000 | Tons | Lime |
| 7,000 | Tons | Sulphur |
| 6,000 | Tons | Litharge |
| 10,000 | Tons | Calcium Chloride |
| 4,800,000 | Gal. | Organic Solvents |

# CHEMICAL CONSUMING INDUSTRIES

## RAYON AND ALLIED PRODUCTS

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 32 |
| Wage earners (ave. for yr.) | 50,550 |
| Wages | $50,693,182 |
| Cost of materials, fuel, and purchased electric energy | $64,505,631 |
| Value of products | $185,159,534 |
| Value added by manufacture | $120,653,903 |

## CLEANING PREPARATIONS

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 395 |
| Wage earners (ave. for yr.) | 2,757 |
| Wages | $3,033,449 |
| Cost of materials, fuel, and purchased electric energy | $17,279,340 |
| Value of products | $42,658,397 |
| Value added by manufacture | $25,379,057 |

## SOAP

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 238 |
| Wage earners (ave. for yr.) | 13,911 |
| Wages | $15,339,045 |
| Cost of materials, fuel, and purchased electric energy | $139,423,048 |
| Value of products | $239,152,130 |
| Value added by manufacture | $99,729,082 |

### Rayon

| Product | | 1935 | 1933 |
|---|---|---|---|
| Rayon and Allied Products, total: | value | $185,159,534 | $156,931,519 |
| Yarns, total: | lb. | 257,557,347 | 213,497,850 |
| | value | $146,067,470 | $129,202,305 |
| Finer than 100 denier: | lb. | 8,661,701 | |
| | value | $7,337,468 | 61,165,733 |
| 100 to 124 denier | lb. | 49,834,517 | $46,684,931 |
| | value | $35,439,233 | |
| 125 to 150 denier | lb. | 152,156,504 | 129,538,587 |
| | value | $80,790,324 | $71,587,582 |
| Heavier than 150 denier | lb. | 46,904,625 | 22,793,530 |
| | value | $22,500,445 | $10,929,792 |
| Allied products (sheets, waste, etc.) | value | $32,671,353 | $27,729,214 |
| Other products | value | $6,420,711 | |

Production of Yarn, by Processes: 1935

| | Pounds | Value |
|---|---|---|
| Total production, all processes | 257,557,347 | $146,067,470 |
| Viscose and cuprammonium processes | 201,964,505 | $110,227,777 |
| Cellulose acetate process | 55,592,842 | $35,839,693 |

### Plastics

| Product | | 1935 | 1933 |
|---|---|---|---|
| Plastics, total value | | $44,163,055 | $24,188,191[1] |
| Nitrocellulose (pyroxylin):— | | | |
| Number of establishments: | | 13 | 12 |
| Total production (not including finished articles) | lb. | 16,367,689 | 12,945,556 |
| Made and consumed in same establishment | lb. | 3,013,603 | 2,849,523 |
| Produced for sale: | lb. | 13,354,086 | 10,096,033 |
| | value | $10,682,358 | $7,799,283 |
| Finished articles of pyroxylin made in the producing establishments in "Chemicals n. e. c." industry[2] | value | $5,116,420 | $4,303,765 |
| Cellulose acetate: | no. of est. | 6 | 6 |
| | lb. | 10,288,753 | [1] 2,874,819 |
| | value | $7,936,686 | [1] $2,245,543 |
| Coal-tar resins, total: | lb. | 89,027,899 | 41,556,515 |
| | value | $15,992,691 | $7,508,587 |
| Derived from — | | | |
| Phenol and/or cresol: | no. of est. | 24 | |
| | lb. | 53,573,353 | |
| | value | $10,307,017 | |
| Phthalic anhydride: | no. of est. | 8 | |
| | lb. | 17,963,284 | [3] |
| | value | $2,890,054 | |
| Other coal-tar resins: | no. of est. | 7 | |
| | lb. | 17,491,262 | |
| | value | $2,795,620 | |
| Other synthetic resins, including synthetic rubber: | value | $4,434,900 | $2,331,013 |

[1] Revised.
[2] In addition, nitrocellulose articles are made from purchased nitrocellulose plastics by establishments in a number of other industries, including "Synthetic-Resin, Cellulose-Plastic, Vulcanized-Fibre and Molded and Pressed Pulp Fabricated Articles, not Elsewhere Classified" and "Brushes, Other than Rubber."
[3] No data.

### Soap and Cleaning Preparations

| Product | | 1935 | 1931[1] |
|---|---|---|---|
| Soap Industry Proper: | lbs. | 1,496,553,270 | 1,736,742,454 |
| Bar Soap, total: | value | $104,329,024 | $121,449,272 |
| Granulated, powdered and sprayed: | lb. | 502,122,591 | 421,803,780 |
| | value | $45,206,462 | $40,976,787 |
| Bar cleansers containing soap: | lb. | 7,469,529 | [2] |
| | value | $466,346 | [2] |
| Soap chips and flakes, bulk: | lb. | 151,659,892 | [2] |
| | value | $10,713,357 | [2] |
| packaged: | lb. | 307,274,876 | [2] |
| | value | $25,615,958 | [2] |
| Shaving soap, total: | lb. | [2] | [2] |
| | value | $9,210,700 | [2] |
| Hand pastes or mechanics' paste: | lb. | 13,579,676 | [2] |
| | value | $735,547 | [2] |
| Textile soap, including potash and foot soap: | lb. | 67,521,396 | [2] |
| | value | $5,176,564 | [2] |
| Potash soap, other than textile and liquid: | lb. | 20,523,776 | [2] |
| | value | $1,466,490 | [2] |
| Liquid soap, not including packaged shampoos: | lb. | 18,817,893 | [2] |
| | value | $1,157,608 | [2] |
| Soap stock or soap base: | lb. | 3,665,376 | 8,977,784 |
| | value | $270,406 | $546,682 |
| Soap not reported according to above classifications: | lb. | [2] | [2] |
| | value | $1,676,708 | $75,089,381 |
| Cleaning and Polishing Preparations: | | | |
| Washing powders, packaged: | lb. | 132,681,612 | [2] |
| | value | $5,535,464 | [2] |
| bulk: | lb. | 81,881,760 | [2] |
| | value | $2,115,862 | [2] |
| Cleansers, scouring powders, and washing compounds, containing soap, packaged: | lb. | 377,011,083 | [2] |
| | value | $14,172,741 | [2] |
| bulk: | lb. | 115,407,046 | [2] |
| | value | $3,511,743 | [2] |
| Cleansers, scouring powders, and washing compounds containing no soap, packaged: | lb. | 52,940,034 | [2] |
| | value | $4,169,467 | [2] |
| bulk: | lb. | 221,945,407 | [2] |
| | value | $6,916,682 | [2] |
| Bar cleansers and scouring compounds containing no soap: | lb. | 1,256,927 | [2] |
| | value | $191,050 | [2] |
| Dry cleaning preparations: | value | $1,558,145 | [2] |
| Cleaning preparations containing no soap, not reported by kind: | value | $5,008,505 | $9,392,428 |
| Cleaning preparations containing soap: | value | $5,194,357 | |
| Other cleaning preparations: | value | $897,042 | $2,673,158 |
| Polishing preparations, total: | value | $14,839,339 | $15,840,683 |
| Metal polish: | value | $1,806,481 | $2,719,657 |
| Automobile-body polish: | value | $2,514,581 | $2,772,403 |
| Floor wax (liquid and paste): | value | $6,335,198 | $4,990,877 |
| Others (furniture, floor, etc.): | value | $4,183,079 | $5,348,746 |
| Paint and varnish removers: | gal. | 1,842,793 | [3] |
| | value | $1,996,491 | $1,815,592 |

[1] No comparable data for 1933 available due to a change in census classifications.
[2] No comparable data on these items are available for any year due to a change in census classifications.
[3] No data.

## ESTIMATED CONSUMPTION OF CHEMICALS

### Soap and Cleaning Preparations

| | | |
|---|---|---|
| 656,827 | Tons | Fats and Oils |
| 96,000 | Tons | Caustic Soda |
| 70,000 | Tons | Soda Ash |
| 155,000 | Tons | Silicate of Soda |
| 113,000 | Tons | Lime |
| 6,000 | Tons | Sulphuric Acid (50 deg.) |
| 8,000 | Tons | Muriatic Acid (20 deg.) |
| 100,000 | Tons | Salt |
| 8,000 | Tons | Caustic Potash |
| 185,000 | Gal. | Ethyl Alcohol |

### Rayon

| | | |
|---|---|---|
| 111,250 | Tons | Sulphite Pulp |
| 160,000 | Tons | Caustic Soda (76%) |
| 309,000 | Tons | Sulphuric Acid (50 deg.) |
| 45,700 | Tons | Carbon Bisulphide |
| 22,500 | Tons | Glucose |
| 18,000 | Tons | Glacial Acetic Acid |
| 6,700 | Tons | Acetone |
| 500 | Tons | Ammonia (Anhydrous) |
| 320 | Tons | Copper Sulphate |
| 59,000 | Tons | Other Chemicals |

### Plastics

| | | |
|---|---|---|
| 5,500,000 | Wine Gal. | Alcohol |
| 1,050 | Tons | Urea |
| 18,000 | Tons | Phenol |
| 19,000 | Tons | Formaldehyde |
| 5,300 | Tons | Sulphuric Acid (100%) |
| 9,600 | Tons | Nitric Acid (100%) |

# COMMODITY MARKETS IN

## SUGAR

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 169 |
| Wage earners (ave. for yr.) | 26,008 |
| Wages | $24,782,379 |
| Cost of materials, fuel, and purchased electric energy | $425,621,319 |
| Value of products | $498,645,860 |
| Value added by manufacture | $73,033,541 |

## PULP

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 188 |
| Wage earners (ave. for yr.) | 23,623 |
| Wages | $23,401,212 |
| Cost of materials, fuel, and purchased electric energy | $96,246,588 |
| Value of products | $167,208,261 |
| Value added by manufacture | $70,961,673 |

## PAPER

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 591 |
| Wage earners (ave. for yr.) | 103,345 |
| Wages | $110,200,308 |
| Cost of materials, fuel, and purchased electric energy | $429,113,355 |
| Value of products | $711,793,299 |
| Value added by manufacture | $282,679,944 |

### Sugar

| Product | | 1935 | 1933 |
|---|---|---|---|
| Beet Sugar Industry, total: | value | $95,159,804 | $127,133,272 |
| Sugar, total: | tons | 1,186,448 | 1,636,462 |
| | value | $89,103,480 | $121,171,347 |
| Granulated: | tons | 1,178,328 | 1,625,954 |
| | value | $88,758,570 | $120,811,768 |
| Unfinished: | tons | 8,120 | 10,508 |
| | value | $344,910 | $359,570 |
| Molasses, sold or transferred to other factories for desugarization: | tons | 145,612 | 177,681 |
| | value | $995,181 | $732,433 |
| Molasses other than for desugarization, total: | tons | 87,924 | 175,134 |
| | value | $796,631 | $877,383 |
| Discarded from desugarization process (exclusive of that used for molasses beet pulp): | tons | 71,050 | 136,744 |
| | value | $618,790 | $617,721 |
| Other: | tons | 16,874 | 38,390 |
| | value | $177,841 | $259,662 |
| Beet pulp, total: | tons | 1,546,003 | 2,013,869 |
| | value | $4,185,397 | $4,219,118 |
| Dried pulp, exclusive of molasses pulp: | tons | 131,727 | 132,580 |
| | value | $1,525,333 | $1,832,859 |
| Moist pulp: | tons | 1,281,323 | 1,751,491 |
| | value | $927,595 | $869,827 |
| Molasses pulp: | tons | 132,953 | 129,798 |
| | value | $1,732,469 | $1,516,432 |
| Other products: | value | $79,115 | $132,991 |
| [1]Cane Sugar Production ,total: | value | $26,280,614 | $18,233,202 |
| Sugar, total: | tons | 350,982 | 236,940 |
| | value | $23,110,766 | $15,281,047 |
| Raw: | tons | 280,840 | 152,955 |
| | value | $15,952,521 | $9,201,426 |
| Granulated: | tons | 64,397 | 65,902 |
| | value | $5,303,944 | $4,825,948 |
| Clarified: | tons | 25,745 | 18,033 |
| | value | $1,854,301 | $1,253,673 |
| Syrup: | gal. | 3,442,982 | 3,404,612 |
| | value | $863,589 | $869,080 |
| Molasses, other than blackstrap: | gal. | 5,438,182 | 8,067,753 |
| | value | $663,966 | $1,044,880 |
| Blackstrap molasses: | gal. | 19,940,843 | 9,643,494 |
| | value | $1,174,952 | $507,062 |
| Bagasse, for sale as such: | tons | 115,785 | 272,257 |
| | value | $278,783 | $453,306 |
| Other products: | value | $188,558 | $77,827 |
| Cane Sugar Refining, total: | value | $377,214,442 | $337,075,225 |
| Refined sugar, hard | tons | 3,914,804 | 3,663,227 |
| | value | $349,280,365 | $313,349,733 |
| Refined sugar, soft or brown: | tons | 295,162 | 275,241 |
| | value | $23,409,448 | $21,091,017 |
| Refiners syrup, edible | gal. | 2,886,558 | 3,692,485 |
| | value | $599,117 | $559,052 |
| Refiners' blackstrap and non-edible syrup: | gal. | 22,305,646 | 19,608,603 |
| | value | $1,320,870 | $841,826 |
| Other sugar products: | value | $1,739,213 | $1,233,597 |

[1] The Cane Sugar Production industry differs from the Cane Sugar Refining industry in that it consists of the mills which actually make sugar and other products from cane, while the refineries process certain portions of the raw sugar already made and convert them to a more usable form.

### Pulp

| Product | | 1935 | 1933 |
|---|---|---|---|
| Mechanical: | tons | 1,355,819 | 1,197,553 |
| | value | $24,972,104 | $23,612,012 |
| Sulphite: | tons | 1,594,748 | 1,327,575 |
| | value | $71,415,585 | $54,508,771 |
| Sulphate: | tons | 1,467,749 | 1,259,353 |
| | value | $36,008,886 | $29,095,663 |
| Soda, semichemical and other: | tons | 489,238 | 457,790 |
| | value | $18,204,824 | $16,471,331 |
| Screenings, total: | tons | 36,672 | 33,935 |
| | value | $401,136 | $384,686 |
| Mechanical: | tons | 3,902 | 4,243 |
| | value | $22,146 | 45,499 |
| Chemical: | tons | 32,770 | 29,692 |
| | value | $378,990 | $339,187 |
| [1] Pulp, other than wood: | tons | 106,630 | 89,464 |
| | value | $15,340,971 | $8,399,010 |

### Paper

| | | 1935 | 1933 |
|---|---|---|---|
| Newsprint and similar paper: | tons | 1,221,871 | 1,213,096 |
| | value | $49,496,538 | $47,836,504 |
| Book paper: | tons | 1,281,870 | 1,080,196 |
| | value | $112,608,975 | $83,244,346 |
| Writing paper (fine): | tons | 541,083 | 478,356 |
| | value | $73,105,846 | $61,329,986 |
| Wrapping paper: | tons | 1,605,457 | 1,440,029 |
| | value | $125,196,748 | $95,767,523 |
| Cover paper: | tons | 20,806 | 12,697 |
| | value | $3,710,430 | $2,104,359 |
| Tissue paper: | tons | 473,314 | 406,760 |
| | value | $46,235,141 | $37,711,156 |
| Absorbent paper: | tons | 95,179 | 79,832 |
| | value | $15,911,243 | $12,081,629 |
| Building paper: | tons | 463,143 | 328,275 |
| | value | $21,084,716 | $14,059,962 |
| Other paper: | tons | 80,582 | 74,486 |
| | value | $8,662,602 | $6,236,235 |
| Boards, total: | tons | 4,722,890 | 4,076,290 |
| | value | $200,103,326 | $161,180,877 |

[1] Cotton pulp, cottonseed-hull-shavings pulp, rag pulp, reclaimed paper pulp, and straw pulp.

### Fertilizers

| Product | | 1935 | 1933 |
|---|---|---|---|
| Complete fertilizers (mixtures containing nitrogen, phosphoric acid and potash): | tons | 4,176,806 | 3,273,744 |
| | value | $92,373,376 | $61,179,998 |
| Potash superphosphates: | tons | 142,076 | 86,868 |
| | value | $2,680,679 | $1,385,040 |
| [1] Superphosphates, not ammoniated: | tons | 1,752,286 | 1,545,782 |
| | value | $16,489,121 | $12,881,735 |
| Fish scrap: | tons | 100,211 | |
| | value | $2,651,594 | |
| Bone meal: | tons | 56,313 | |
| | value | $1,414,115 | |
| Ammoniated superphosphates: (Incl. urea and ammonium nitrate): | tons | 41,278 | [2] 289,568 |
| | value | $608,661 | [2] $7,364,178 |
| Other ammoniated fertilizers (non-potash): | tons | 19,763 | |
| | value | $445,026 | |
| Other fertilizers: | tons | 187,832 | |
| | value | $5,398,484 | |

[1] Basis 16 per cent available phosphoric acid.
[2] Data incomplete.

## ESTIMATED CONSUMPTION OF CHEMICALS

### Pulp and Paper

| | | |
|---|---|---|
| 117,500 | Tons | Alum |
| 40,000 | Tons | Caustic Soda |
| 18,000 | Tons | Casein Size |
| 146,000 | Tons | Chlorine |
| 344,500 | Tons | Lime |
| 188,090 | Tons | Limestone |
| 88,000 | Tons | Rosin |
| 204,000 | Tons | Sulphur |
| 283,600 | Tons | Silicate of Soda |
| 225,000 | Tons | Salt Cake |
| 80,000 | Tons | Soda Ash |

### Fertilizers

| | | |
|---|---|---|
| 1,980,000 | Tons | Phosphate Rock |
| 1,825,000 | Tons | Sulphuric Acid (50 deg.) |
| 436,000 | Tons | Muriate of Potash |
| 55,000 | Tons | Sulphate of Potash |
| 20,000 | Tons | Other Potash Salts |
| 55,000 | Tons | Liming Materials |
| 580,000 | Tons | Sodium Nitrate |
| 570,000 | Tons | Ammonium Sulphate |
| 70,000 | Tons | Anhydrous Ammonia |
| 240,000 | Tons | Other Inorganic N Carriers |
| 340,000 | Tons | Organic N Carriers |

### Sugar Industry

| | | |
|---|---|---|
| 6,000 | Tons | Sulphur |
| 427,400 | Tons | Lime and Limestone |
| 10,500 | Tons | Kieselguhr |
| 100 | Tons | Bone char. |

# CHEMICAL CONSUMING INDUSTRIES

### FERTILIZERS

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 670 |
| Wage earners (ave. for yr.) | 17,473 |
| Wages | $10,967,021 |
| Cost of materials, fuel, and purchased electric energy | $93,364,605 |
| Value of products | $140,386,112 |
| Value added by manufacture | $47,021,417 |

### CERAMICS

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 1,350 |
| Wage earners (ave. for yr.) | 73,744 |
| Wages | $62,779,006 |
| Cost of materials, fuel, and purchased electric energy | $56,204,132 |
| Value of products | $178,573,018 |
| Value added by manufacture | $122,368,886 |

### GLASS AND GLASSWARE

*United States Census for 1935*

| | |
|---|---|
| Number of establishments | 213 |
| Wage earners (ave. for yr.) | 67,138 |
| Wages | $71,443,178 |
| Cost of materials, fuel, and purchased electric energy | $110,008,152 |
| Value of products | $283,925,061 |
| Value added by manufacture | $173,916,909 |

### Ceramics *

| Product | | 1935 | 1933 |
|---|---|---|---|
| Clay products other than pottery: | Total value | $89,989,246 | $52,771,514 |
| Common brick: | thousands | 1,805,833 | 1,019,810 |
| | value | $18,246,059 | $8,816,452 |
| Face brick: | thousands | 563,662 | 270,323 |
| | value | $6,922,957 | $3,807,379 |
| Hollow brick: | thousands | 9,081 | 4,309 |
| | value | $246,149 | $79,607 |
| Terra Cotta: | short tons | 17,552 | 25,604 |
| | value | $1,527,966 | $1,830,999 |
| Hollow building tile: | short tons | 908,100 | 607,685 |
| | value | $5,439,158 | $2,836,156 |
| Tile (other than hollow and drain): | sq. ft. | 62,695,765 | 38,679,170 |
| | value | $10,598,820 | $6,434,239 |
| Vitrified brick and plates:[2] | thousands | 83,252 | 63,111 |
| | value | $1,895,293 | $1,224,332 |
| Draintile: | short tons | 264,123 | 167,980 |
| | value | $2,001,570 | $1,127,254 |
| Sewer pipe: | short tons | 670,181 | 451,272 |
| | value | $8,616,123 | $4,911,104 |
| Stove lining: | short tons | 7,614 | 5,827 |
| | value | $236,332 | $224,371 |
| Flue lining: | short tons | 98,484 | 45,437 |
| | value | $1,172,263 | $471,155 |
| Chimney pipe and tops: | short tons | 4,251 | 5,274 |
| | value | $91,856 | $57,151 |
| Wall coping: | short tons | 19,094 | 7,612 |
| | value | $222,997 | $80,442 |
| Segment blocks: | short tons | 9,169 | (1) |
| | value | $105,540 | (1) |
| Fire-clay products: | value | $23,832,348 | $16,127,758 |
| Glass-house tank blocks, melting pots, stoppers, floaters and rings: | short tons | 27,525 | 22,065 |
| | value | $2,441,113 | $1,757,118 |
| Refractory cement (clay): | short tons | 35,944 | 26,375 |
| | value | $1,660,118 | $1,056,593 |
| Clay sold, raw or prepared: | short tons | 252,670 | 192,207 |
| | value | $1,190,559 | $1,012,483 |
| Other clay products, except pottery: | value | $3,566,875 | $916,921 |
| Nonclay refractories, total: | value | $20,591,992 | $12,069,517 |
| Graphite and other carbon: | value | $1,487,736 | (1) |
| Magnesite and chrome bricks: | thousands | 12,112 | 9,027 |
| | value | $3,424,726 | $2,579,994 |
| Silica brick: | thousands | 149,621 | 110,889 |
| | value | $8,179,990 | $4,654,776 |
| Refractory cement (nonclay): | short tons | 38,931 | 42,099 |
| | value | $903,351 | $1,130,409 |
| Other nonclay refractories including those of a lumina and silicon carbide: | value | $6,596,180 | $2,946,342 |
| Pottery, total: | value | $67,388,347 | $44,024,348 |
| Vitreous-china plumbing fixtures: | value | $12,969,481 | $7,709,353 |
| Semi-vitreous or porcelain plumbing fixtures: | value | $523,195 | $646,705 |
| Red earthenware (flower pots, etc.): | value | $1,795,144 | $1,207,396 |
| Stoneware (except chemical): | value | $1,578,673 | $2,065,636 |
| Chemical stoneware: | value | $617,042 | $383,067 |
| White ware, including cream color: | value | $22,164,329 | $15,005,178 |
| Hotel china: | value | $7,197,700 | $5,007,669 |
| Porcelain electrical supplies:[3] | value | $11,904,820 | $7,055,580 |
| Garden pottery: | value | $397,662 | $176,396 |
| Art pottery: | value | $2,662,407 | $1,489,382 |
| Gas radiants and backwalls in portable stoves: | value | $428,300 | [1] |
| Saggers (of own make): | value | $408,952 | $326,444 |
| Other pottery products: | value | $4,740,642 | $2,951,542 |
| Sand-lime brick: | thousands | 61,757 | 22,904 |
| | value | $554,631 | $195,318 |

* The Ceramics Industry as used here includes the Clay Products Industries, the Nonclay Refractories Industry, the Pottery Industry, and the Sand-lime Brick Industry.

[1] No data.

[2] Value of metal fittings included, $1,039,435.

[3] Does not include $75,150 of sewer liners.

### Glass and Glassware

| Product | | 1935 | 1931 |
|---|---|---|---|
| Glass and glassware, aggregate value: | | $278,201,771 | $211,955,360 |
| Flat glass, total: | value | $68,266,602 | (1) |
| Polished plate: | sq. ft. | 177,263,473 | 87,017,237 |
| | value | $41,818,918 | $25,765,129 |
| Window glass: | sq. ft. | 428,938,357 | 266,772,159 |
| | value | $18,180,053 | $10,307,396 |
| Obscured glass: | sq. ft. | 14,372,434 | 17,796,456 |
| | value | $1,644,356 | $2,388,936 |
| Wire glass: | sq. ft. | 11,960,829 | 15,663,837 |
| | value | $1,369,144 | $1,800,406 |
| Other flat glass: | value | $5,254,131 | (2) |
| Glassware, total: | value | $67,442,258 | (1) |
| Machine-made tableware: | value | $23,361,221 | (3) $24,263,399 |
| Hand-made tableware: | value | $11,388,516 | |
| Lighting glassware, total: | value | $16,500,453 | (1) |
| Shades, globes, reflectors, etc: | value | $5,812,459 | $6,590,032 |
| Lamp chimneys: | dozens | 2,432,509 | 1,597,144 |
| | value | $1,294,516 | $1,100,251 |
| Lantern globes: | dozens | 615,998 | 403,759 |
| | value | $494,516 | $382,904 |
| Other lighting glassware, including electric-light bulbs, lamps, etc.: | value | $8,898,962 | (2) |
| Lenses, total:[4] | value | $1,875,751 | $1,361,869 |
| Motor vehicle: | dozens | 1,953,768 | 1,397,634 |
| | value | $1,118,062 | $884,009 |
| Other: | dozens | 91,250 | (1) |
| | value | $757,680 | $477,860 |
| Technical, scientific, and industrial glass (pressed and blown), total: | value | $5,998,432 | (1) |
| Tubing: | pounds | 27,302,189 | 17,291,889 |
| | value | $3,665,971 | $3,140,005 |
| Insulators: | value | $2,332,461 | $806,744 |
| Other: | value | | (2) |
| Pressed and blown glassware (including ovenware) not specified above: | value | $8,317,885 | (5) |
| Glass containers, total: | value | $124,492,570 | (1) |
| Food-product containers: | value | $55,839,093 | (1) |
| Beverage containers: | value | $33,063,560 | $15,641,928 |
| Medicinal and toilet preparations containers: | gross | 14,579,450 | 12,765,353 |
| | value | $30,345,232 | $30,280,297 |
| General purpose containers (carboys, pantry jars, etc.): | dozens | 23,099,199 | 12,344,508 |
| | value | $5,2[illegible]4,685 | $6,615,310 |
| Other glass products: | value | $18,000,341 | $30,581,834 |

[1] Data incomplete.

[2] Included in value of "other glass products."

[3] Includes value of ovenware, and is therefore not comparable with corresponding total for 1935.

[4] So-called lenses for use in headlights, lighthouses, lanterns, etc. Optical lenses are classified in the Optical Goods Industry.

[5] Included in machine-made and hand-made tableware. (See footnote 3).

## ESTIMATED CONSUMPTION OF CHEMICALS

### Textile Processing

41,500 Tons Dyestuffs
75,000 Tons Starch
185,000 Tons Soap
90,000 Tons Sulphuric Acid (50 deg.)
34,000 Tons Caustic Soda
48,000 Tons Soda Ash
23,500 Tons Acetic Acid (28%)
10,000 Tons Chlorine
15,000 Tons Other Bleaches
92,000 Tons Sodium Sulphate
21,000 Tons Sodium Phosphates

### Ceramics

91,944 Tons Feldspar
1,834 Tons White Lead
6,751 Tons Litharge
867 Tons Red Lead
3,000 Tons Salt
1,833,637 Tons Clay

### Glass and Glassware

2,334,887 Tons Silica Sand
559,117 Tons Grinding Sand
664,006 Tons Soda-Ash
41,189 Tons Salt Cake
216,074 Tons Lime
162,050 Tons Limestone
103,499 Tons Feldspar
11,600 Tons Fluorspar

# COMMODITY MARKETS IN CHEMICAL CONSUMING INDUSTRIES

## RUBBER

*United States Census for 1935*

| | |
|---|---|
| Number of establishments. | 465 |
| Wage earners (ave. for yr.). | 114,612 |
| Wages | $133,659,754 |
| Cost of materials, fuel, and purchased electric energy | $368,478,339 |
| Value of products | $677,437,237 |
| Value added by manufacture | $308,958,898 |

## LEATHER

*United States Census for 1935*

| | |
|---|---|
| Number of establishments. | 384 |
| Wage earners (ave. for yr.). | 50,877 |
| Wages | $ 55,683,471 |
| Cost of materials, fuel, and purchased electric energy | $197,969,858 |
| Value of products | $308,344,763 |
| Value added by manufacture | $110,374,905 |

## LIME AND CEMENT

*United States Census for 1935*

| | |
|---|---|
| Number of establishments. | 342 |
| Wage earners (ave. for yr.). | 28,193 |
| Wages | $26,955,811 |
| Cost of materials, fuel, and purchased electric energy | $51,857,712 |
| Value of products | $143,739,200 |
| Value added by manufacture | $91,881,488 |

### Rubber

| Products | | 1935 | 1933 |
|---|---|---|---|
| Tires and inner tubes, total: | value | $370,347,474 | $256,512,514 |
| Pneumatic tires and casings: | | | |
| Motor-vehicle (except motorcycle and bicycle): | number | $48,764,713 | $45,375,552 |
| | value | $319,034,157 | $221,050,554 |
| Motorcycle and bicycle: | number | 4,006,476 | |
| | value | $3,690,310 | |
| Inner tubes: | | | |
| Passenger car, truck and bus: | number | 47,760,679 | 46,811,770 |
| | value | $43,816,374 | $31,715,479 |
| Airplane: | number | 20,242 | |
| | value | $67,059 | |
| All other, including motorcycle and bicycle: | number | 1,529,790 | |
| | value | $659,295 | |
| Solid and cushion tires: | | | |
| Truck and bus for highway transportation: | number | 36,790 | |
| | value | $1,517,759 | |
| Industrial truck, tractor and trailer: | number | 116,852 | |
| | value | $844,992 | $3,746,181 |
| All other (including carriage and other tiring): | number | 6,993,794 | |
| | value | $717,518 | |
| Boots and Shoes: | value | $48,261,613 | $41,513,460 |
| Rubber goods other than tires, inner tubes, and boots and shoes, total: | value | $248,634,686 | $170,538,990 |
| Rubber heels: | pairs | 278,369,016 | 272,504,312 |
| | value | $11,594,192 | $11,119,047 |
| Rubber soles: | pairs | 69,655,749 | 91,994,794 |
| Rubber-soling strips and top-lift sheets: | value | $7,258,594 | $8,315,846 |
| | sq. ft. | 9,943,849 | 10,752,949 |
| | value | $2,667,089 | $1,711,451 |
| Rubberized fabrics: | value | $19,933,310 | $18,197,918 |
| Mechanical rubber goods: | | | |
| Rubber belting: | lb. | 48,231,120 | 30,627,804 |
| | value | $20,438,077 | $12,928,458 |
| Rubber hose: | lb. | 93,568,192 | (1) |
| | value | $24,382,401 | $16,761,566 |
| Rubber tubing: | lb. | 13,607,924 | 13,280,049 |
| | value | $2,235,798 | $1,312,507 |
| Rubber packing: | lb. | 10,915,570 | 9,328,083 |
| | value | $2,588,695 | $1,872,387 |
| Washers, gaskets, etc.: | lb. | 5,168,301 | 3,811,441 |
| | value | $2,106,441 | $1,473,651 |
| Rubber and friction tape: | lb. | 12,380,235 | 11,439,375 |
| | value | $2,851,788 | $2,134,313 |
| Rubber covered rolls: | value | $3,727,742 | $2,660,551 |
| Other mechanical rubber goods: | value | $32,311,473 | $15,870,856 |
| Hard-rubber goods (except druggists' sundries) | value | $14,023,739 | $9,927,599 |
| Druggists and medical sundries: | value | $7,597,680 | $5,755,593 |
| Rubber erasers and bands: | lb. | 4,815,619 | (1) |
| | value | $1,762,929 | (1) |
| Rubber gloves: | doz. prs. | 1,287,773 | 1,009,528 |
| | value | $2,857,419 | $1,676,196 |
| Rubber cement: | gal. | 5,518,141 | 3,742,018 |
| | value | $2,851,984 | $2,099,595 |
| Rubber flooring: | sq. ft. | 5,905,877 | 4,325,019 |
| | value | $1,704,421 | $1,237,010 |
| Rubber mats and matting: | value | $8,959,476 | $3,926,486 |
| Tire sundries and repair materials, including camelback: | value | $14,035,000 | (1) |
| Rubber thread, jar rings, and bathing caps: | value | $5,790,690 | $5,358,696 |
| Sponge-rubber products, n. e. c.: | value | $4,237,980 | $1,489,832 |
| Reclaimed rubber produced: | lb. | 241,919,685 | (1) |
| | value | $10,703,448 | (1) |

(1) No comparable data.

### Leather

| Product | | 1935 | 1931 [2] |
|---|---|---|---|
| Sole and belting leather, total: | value | $89,678,756 | $76,102,481 |
| Oak and union sole: | number | 16,005,220 | 16,746,135 |
| | value | $61,959,871 | $55,030,073 |
| Chrome and combination sole: | number | 1,186,877 | 447,424 |
| | value | $4,245,891 | $2,174,538 |
| Belting butts, rough: | number | 494,473 | 369,484 |
| | value | $3,681,595 | $2,919,921 |
| Belting butts, curried: | number | 466,204 | 266,240 |
| | value | $4,448,330 | $2,784,529 |
| Offal (heads, bellies, shoulders, etc.): | pounds | 91,542,072 | 86,161,457 |
| | value | $15,343,060 | $13,193,420 |
| Harness leather: | value | $4,365,804 | $2,166,068 |
| Bag, case, and strap leather (sides): | number | 1,106,351 | 786,684 |
| | value | $5,623,597 | $3,656,258 |
| Skirting leather (sides): | number | 54,374 | 30,448 |
| | value | $387,499 | $255,130 |
| Collar leather (sides): | number | 318,232 | 180,474 |
| | value | $1,104,169 | $627,129 |
| Latigo leather (sides): | number | 17,997 | (1) |
| | value | $91,394 | (1) |
| Lace leather (sides): | number | 133,162 | 127,823 |
| | value | $542,330 | $575,400 |
| Welting leather: | pounds | 5,623,467 | 2,076,568 |
| | value | $1,956,238 | $711,545 |
| Upholstery leather (automobile, furniture): | value | $6,230,810 | $5,199,798 |
| Upper leather (other than fancy and patent): | value | $127,314,820 | (1) |
| Lining leather, total: | value | $9,081,273 | (1) |
| Patent upper leather: | value | $5,068,492 | (1) |
| Glove and garment leather: | value | $18,129,258 | $16,728,647 |
| Fancy and bookbinders' leather, including fancy upper leather: | value | $6,262,995 | $10,494,804 |
| Splits, finished, other than wax and finished upper and upholstery (side splits): | number | 17,230,194 | (1) |
| | value | $7,175,709 | (1) |
| Miscellaneous leather, total: | value | $9,604,343 | $36,863,723 |

(1) No comparable data.
(2) No comparable data for 1933.

### Lime and Cement

| Product | | 1935 | 1931 |
|---|---|---|---|
| Lime, all kinds, total: | tons | [1] 2,476,345 | 2,932,558 |
| | value | [1] $18,423,448 | $18,029,745 |
| Quicklime: | tons | 1,414,650 | 1,480,930 |
| | value | $10,005,627 | $9,461,093 |
| Hydrated lime: | tons | 837,876 | 1,144,363 |
| | value | $7,074,183 | $7,137,739 |
| Agricultural lime: | tons | 223,819 | 307,265 |
| | value | $1,343,638 | $1,430,913 |
| Not distributed by kind: | | (2) | (2) |
| Cement, all kinds, total: | bbl. | 76,250,005 | 64,715,171 [3] |
| | value | $114,942,212 | $86,172,365 [3] |
| Portland cement: | bbl. | 75,238,594 | 64,282,756 [3] |
| | value | $113,504,670 | $85,600,717 [3] |
| Natural, pozzolan, and masonry cement: | bbl. | 1,011,411 | 432,415 [3] |
| | value | $1,437,542 | $571,648 [3] |

[1] Incomplete.
[2] Data lacking.
[3] Figures for 1933

## ESTIMATED CONSUMPTION OF CHEMICALS

### Rubber

| | | |
|---|---|---|
| 106,850 | Tons | Carbon Black |
| 57,770 | Tons | Zinc Oxide (Incl. leaded) |
| 19,440 | Tons | Lithopone |
| 3,171 | Tons | Litharge |
| 4,300 | Tons | Accelerators |
| 3,900 | Tons | Antioxidants |
| 523,000 | Tons | Crude Rubber |
| 85,400 | Tons | Reclaimed Rubber |
| 37,000 | Tons | Sulphur |
| 12,300 | Tons | Caustic Soda |

### Leather

| | | |
|---|---|---|
| 11,000 | Tons | Sodium Sulphide |
| 5,000 | Tons | Lactic Acid |
| 170,000 | Tons | Tanning Extracts |
| 3,000 | Tons | Sulphuric Acid (50 deg.) |
| 350,000 | Tons | Salt |
| 4,00 | Tons | Sodium Bichromate |
| 13,000 | Tons | Sodium Thiosulphate |
| 2,000 | Tons | Borax |
| 11,000 | Tons | Oils and Fats |
| 2,500 | Tons | Dyes |
| 50,000 | Gal. | Alcohol |

### Lime and Cement

| | | |
|---|---|---|
| 24,290,000 | Tons | Limestone and Cement Rock |
| 2,400,000 | Tons | Clay and Shale |
| 600,000 | To | Blast Furnace Slag |
| 660,000 | Tons | Marl |
| 460,000 | Tons | Uncalcined Gypsum |
| 700,000 | Tons | Oyster Shells, etc. |